

The Geography of California



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THE PROVINCES OF CALIFORNIA

1—The Sierra Nevada Mountains
2—The Great Valley

3—The Coast Ranges
4—Southern California
5—Klamath Mountains

6—The Volcanic Plateau
7—The Great Basin

THE GEOGRAPHY OF CALIFORNIA

BY

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Etc.*

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CONTENTS

PART I.

		INTRODUCTION.	PAGE
Chapter	I.	GENERAL SURVEY OF CALIFORNIA	1
Chapter	II.	ORIGIN OF THE SURFACE FEATURES	6
Chapter	III.	THE COAST LINE OF CALIFORNIA	10
Chapter	IV.	THE CLIMATE OF CALIFORNIA	16
Chapter	V.	NATURAL RESOURCES	24
		Water Supply	24
		Soil	28
		Vegetation	30
		Animal Life	38
		Minerals	40
Chapter	VI.	PRIMITIVE INHABITANTS	47
Chapter	VII.	SUCCESSIVE DEVELOPMENT OF DIFFERENT OCCUPATIONS	50
Chapter	VIII.	IMPORTANCE OF IRRIGATION IN CALIFOR- NIA	55
Chapter	IX.	DEVELOPMENT OF INDUSTRIAL AND COM- MERCIAL LIFE	57

PART II.

Chapter	X.	THE DIFFERENT NATURAL REGIONS OR PROVINCES	60
Chapter	XI.	THE SIERRA NEVADA MOUNTAINS	62
		Mountain Passes	65
		Geographical Story of the Sierra Nevada Moun- tains	67
		The Scenic Features of the Mountains	69
		Economic Importance	73
Chapter	XII.	THE GREAT VALLEY PROVINCE	78
		Drainage	79
		Climate	81
		Industrial Development	83
Chapter	XIII.	THE COAST RANGES	88
		Drainage	93
		Climate of the Coastal Region	97
		Mountain Passes: Lines of Communication	99
		Old Levels of the Mountains	103
		Ancient Volcanoes	104
		Great Earthquake Rift	105
		Natural Resources	107

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CONTENTS—Continued

	PAGE
Chapter XIV. SOUTHERN CALIFORNIA	111
Relief and Drainage	111
Lakes	125
Coast and Islands	126
Earthquake Lines	129
Geographic History	132
Geographic Barriers	134
Climate	137
Natural Resources	138
Value of Different Slopes	140
Industrial Development	142
Chapter XV. KLAMATH MOUNTAIN REGION	147
Location and Boundaries	147
Physical Features	148
Climatic Features	151
Resources	152
Chapter XVI. THE VOLCANIC PLATEAU REGION	154
Volcanoes and Recent Eruptions	156
Climate	158
Resources	158
Chapter XVII. THE GREAT BASIN PROVINCE	160
Extent and General Character	160
Surface Features	161
Climate	169
Natural Resources	172
APPENDIX	175



THE GEOGRAPHY OF CALIFORNIA.

INTRODUCTION.

The geography of California is a vast and many sided subject which has never yet been adequately treated. It is not the intention of the author in presenting this little hand-book to take up the subject in an exhaustive manner, for that would require a large volume. Nor is his intention to present a mere description of the various aspects of the geography of the State, for this has already been done, although in an inadequate manner, in various little school supplements and advertising pamphlets. Moreover, mere description cannot impart real geographic knowledge, since we must know something of causes and relations.

The object which the author has in mind is rather to give a simple and yet detailed description of the conditions under which we are living, and weave them into a connected and rational whole, so that teachers and pupils may acquire the elements of a rational knowledge of California. As our work in geography is at present outlined it is ridiculously unphilosophical as well as thoroughly inadequate.

The geography of California is extraordinarily varied and interesting. Children should not leave school without some elementary conceptions of the origin and meaning of the physical features about them, of the strongly contrasted climatic conditions, and of the influence which these exert upon our lives.

To meet the above need the author has woven together in as simple manner as possible those facts and relations which should be known and appreciated by every educated resident of California.

CHAPTER I.

A GENERAL SURVEY OF CALIFORNIA.

The fabled "Isle of California" described in an old Spanish romance as lying in the South Seas was peopled with Amazons, Griffins, and contained stores of gold. What was more natural then, than that the large body of land discovered off the west coast of Mexico by a Spanish commander under Cortez, and supposed to be an island, should receive the name of California? To be sure, the new land was not known to contain gold, or had any monsters been seen, but this mattered little to the imaginative Spaniards.

For more than two hundred years there was difference of opinion as to whether this land which we now know as Lower California was an island or a part of the mainland. In a geography published in London in 1725 California is described and mapped as a large island extending north to the Straits of Anian (Puget Sound). In this book all that is known of California is given in one paragraph, a part of which reads as follows: "This island was formerly esteemed a peninsula, but now found to be entirely surrounded with water. Its north part was discovered by Sir Francis Drake; Anno 1577, and by him called New Albion, where, erecting a pillar, he fastened thereto the arms of England. The inland parts were afterwards searched into, and being found to be only a dry, barren, cold country, Europeans were discouraged from sending colonies to the same, so that it still remains in the hands of the natives."

After the establishment, in 1769, of the first of the missions within the boundaries of the present State, the northern portion of that indefinite area to which the name California had been given came to be known as New, or Upper California, while the older known peninsula was called Old, or Lower California.

We find that by 1832 the opinion first formed as to the value of California had given place to a radically different one, as illustrated by Flint's geography of that date. He says: "This picturesque country displays on every side magnificent forests or verdant savannahs, where the herds of deer and elk of enormous size graze undisturbed. The soil is fertile. The vine, olive and wheat prosper. * * * The aspect of the country is charming, and the inhabitants enjoy perpetual spring."

It was not until after the war with Mexico that the boundaries of Upper California became clearly defined, although on the north the forty-second parallel had been previously recognized by treaty with Spain as separating it from the Oregon territory.

As one result of the Mexican war we came into possession of Lower as well as Upper California, but the treaty of peace finally established the southern boundary of the present State near the thirty-second parallel. The original draft of the treaty included the mouth of the Colorado in the United States, and should have been ratified as it was, for it would have avoided disputes as to the use of the river and saved an arbitrary boundary line across its great and fertile delta.

The eastern boundary of California, during Mexican rule was quite indefinite. It was held, on the one hand,

that the summit of the Sierra Nevada or Snowy Mountains was the eastern limit, while on the other, the country as far east as Colorado was included in the territory. The line as finally established, however, followed a middle course, including a strip of the desert country east of the Sierras which geographically belongs with Nevada.

The only natural features, then, which sharply set off California from the adjacent regions are the Pacific ocean upon the west, and the Colorado river upon the southeast. Notwithstanding this fact the coastal region and the Great Valley with its tributary slopes are so isolated by mountains and deserts that with the primitive means of travel in the early days they were extremely difficult to reach.

The water route by the Isthmus or Cape Horn was long and dangerous. The Sierra Nevadas formed a wall upon the east which it was almost impossible to pass except at favorable seasons of the year, while on the north cañons and mountains almost as difficult of passage separated California from Oregon.

The Colorado river formed no great obstacle, for its mighty cañon lies out of the direct line from the east, yet both to the east and west of it were vast deserts which, stretching far north across Nevada, almost encircled the mountain barrier, adding very greatly to the danger and difficulty of emigrant travel. When, however, the emigrants had reached San Francisco by water, or had finally passed the Sierras and entered the Great Valley, the topography of the country was found to be such, with the streams and valleys converging to San Francisco

Bay, that they could gain with little trouble almost any point in the central and northern portions of the State.

The emigrant, who came the southern route across Arizona and entered Southern California, was still far from being past the difficulties of his journey if he wished to gain the "gold diggings." The Mohave Desert, with its bounding mountains, forms a wedge almost cutting the State into two parts. The only way to reach Northern and Central California was either to cross the mountain ranges and desert, or by keeping close to the coast, take advantage of a passage between a spur of the mountains and the sea. The trail led along a narrow beach beneath the cliffs and was impassable at high tide. In addition, several mountain ranges had to be crossed on the latter route. California is thus seen to be a political unit with a very complex geographical character. Physical and climatic barriers appear to have played an unusually insignificant part in the setting of its boundaries.

The influence of the waterways upon the discovery and settlement of California was much less than is usually the case with new countries. The Colorado river was practically useless because of the great cañon in which it is buried throughout the most of its course. In addition, its lower portion is shallow and its mouth in such a remote and inaccessible region that it was almost unused in the early days. No other streams were available for those attempting to cross the continent, although for some years previous to Fremont's explorations, it was erroneously supposed, and this error crept into the maps of that time, that a great river known as the Buenaventura rose in a lake in the Rocky Mountains and flowed west-

erly into San Francisco Bay. Fremont attempted to find this supposed river when caught in the deserts of northern Nevada with winter coming on, and nearly perished in the snows of the Sierra Nevada range which was found to lie directly across the path of the imaginary stream.

With California hemmed in by mountains and deserts upon the land side, it would surely seem that in the Pacific Ocean, which borders it for such a long distance, we would find an easy way of approach. However, the records of the various exploring expeditions which visited the Pacific coast of North America show that they were repeatedly driven southward by the northwesterly winds and storms. Time and again the expeditions sent up the coast from Mexico were beaten back and disabled. Parties traveling by land made better time and encountered fewer difficulties than those upon the ocean. The difficulty of exploring the coast by sea caused both Drake and Visciano to sail past the entrance to San Francisco Bay without seeing it, and led to its interesting discovery by a land expedition under Portola.

CHAPTER II.

ORIGIN OF THE SURFACE FEATURES.

The traveler passing through California encounters the most remarkable diversity of scenery, as well as of climate and productions. Nowhere else in the United States is there to be found in an equal area so many interesting land forms, and nowhere else is shown so clearly the influence which these exert upon climate and life. Within the bounds of California are found nearly all the different types of physical features which make up the surface of the earth. We have, then, in our study of California geography a most remarkable opportunity to learn how completely human life is dependent upon the conditions surrounding it, and how this life has been modified by these conditions.

Although we do not ordinarily realize the fact, the surface of the earth is never at rest. In one place it may be slowly rising, while in another it is sinking. As a rule these movements are so slow that their effects are scarcely noticeable in a lifetime, but now and then, when the strain exerted by the forces within the earth is greater than the crust will stand, the latter breaks and slips, and we experience the sudden jar of an earthquake.

These forces which fold and break the surface operate from within the earth. Upon the outside there are other forces at work whose ultimate effect is to smooth down the surface. Changes of temperature, frost, carbonic acid, etc., are everywhere causing the exposed rocks to crumble and decay, while the streams are the chief agents

which are carrying these materials from the highlands to the lowlands.

In trying to understand the physical geography of California we must remember that the surface as we see it is the result of the interaction of the two forces mentioned. We might say that they are more or less in conflict with each other. The first has folded and broken the earth's surface, making mountains and broad valleys, while the second has been tearing down the mountains and filling up the valleys. During this process of erosion the surface is sculptured into the infinite variety of peak and cañon which we see in the hilly and mountainous portions of the State. If left undisturbed long enough the loftiest mountains will finally be worn down to low hills and even plains.

From what has been said it is clear that the higher and steeper mountains are younger than those with gentle slopes. In different parts of the State there are escarpments which have been made by earthquake movements in quite recent times. Such escarpments are particularly well illustrated along the Great Rift of the Coast Ranges. Although the opening of this rift at the earthquake of 1906 was due to a horizontal strain rather than a vertical one, yet at earlier times the vertical movement predominated, as is shown by long ridges and cliffs, in places several hundred feet high. The grand and picturesque eastern wall of the Sierra Nevada mountains facing Owens Valley was formed by a series of similar displacements extending through a long period of time, and which have amounted to 10,000 feet in the Mt. Whitney

region. The Owens Valley earthquake of 1872 showed that these have not yet stopped.

In going from the Great Valley to Los Angeles we cross the western arm of the Mohave Desert and obtain an excellent view of a topography which contrasts most strongly with that of the mountains just mentioned. This is a region of ancient and almost worn down mountains. No earthquake or other mountain-making movements have disturbed this region for ages. It has been so long subject only to the forces of disintegration and erosion that its once mountainous surface has been reduced almost to a plain. Low hills rise here and there, some of them perhaps still worthy of the name of mountains, but their slopes are gentle, and the accumulations of gravel due to the occasional cloudbursts in places almost cover the remnants of the one-time mountainous surface. This region is in its topographic old age, and the desert waste only adds to the impression of decay and death. Imagination fails to picture the length of time required to accomplish this result, or the number of years that would be required to reduce the lofty Sierra Nevadas to a similar condition.

In the northeastern part of the State we find a different kind of mountains from those described. These are volcanoes, and although apparently extinct, some of them give indications of having been in eruption so recently that we should not be surprised to see them break forth again. Earthquakes and volcanic action have had a great deal to do with the shaping of our State, and both will undoubtedly occur again in this region, as we know they do at the present time in various parts of the earth.

The lofty mountain ranges and volcanic peaks have been formed by forces within the earth. The complex detail, however, of each of these mountain ranges, including rugged peaks, deep precipitous cañons and clustering foothills, is formed by the disintegration and erosion of the solid rocks. The crumbling rock materials are carried away chiefly by running water and deposited in the lowland valleys, which were formed by the down folding of the earth's crust. Thus have come to their present state the great plain-like Sacramento-San Joaquin valley (the Great Valley of California), and the many larger valleys of the Coast Ranges and of Southern California.

CHAPTER III.

THE COAST LINE OF CALIFORNIA.

The whole Pacific region of both North and South America has through the long periods of the past been subject to many and severe disturbances. We can easily see why this is the case, because lying next to the largest and deepest of the oceans the crust must be weakened by the folding along the continental border. Fissures must frequently form in this line of weakness, and through these fissures flow the lavas which have covered so many thousand square miles and built up the lofty volcanoes.

Changes of level are constantly taking place along this border land, and the effects of these are most quickly and readily detected at the meeting point with the water, that is, the shore line. We find remarkable illustrations of both elevation and of submergence of the coastal region throughout the whole length of California.

The particular character of our coast as it exists at present has been determined by two important things. One is the fact of recent submergence and the other is the direction in which the leading mountain ranges extend.

Before taking up in detail the causes which have made our coast line what it is, we must say a few words about the distinction to be made between continental masses and ocean basins. As a usual thing the margins of the continents are marked by downward folding of the earth's crust making a fairly sharp division line between the continental elevations and the ocean basins. It frequently

happens, however, that the actual meeting point of the land and water does not correspond with the real continental border, so that as the land changes its level the edges of the continent may at times be submerged. This is the case with the plateau of North America at the present time. Soundings by the Coast Survey have shown that off California there is a submerged shelf over which the water is in most places comparatively shallow, and outside of which the bottom descends very rapidly to the abyssal depths of the Pacific. Cañon-like depressions extend from near the land across these shallows to the deep water outside. We can explain them in no other way than by assuming that they represent portions of the channels of ancient rivers which were submerged by the sinking of the land.

The continental plateau of which we have been speaking is only about ten miles wide, off the coast of Northern California. Several submerged cañons extend across it, one of which reaches so close to the present shore that a ship taking soundings over it supposed, from the depth, that it was far from the land, and so approached so close to the rocks that it came near being wrecked.

At the Golden Gate the submerged plateau is thirty miles wide, and the water over it so shallow that if the land were to rise 200 feet one could walk dry shod out to the Farallone Islands. These stand near the outer edge of the plateau, and are really but the unsubmerged portions of a line of low granite hills.

The largest of all of the submerged cañons occupies Monterey Bay and extends up so close to the land near

the mouth of the Salinas river that a wharf and shipping point has been established there.

The plateau is very narrow opposite the coast of Monterey county, where the steep slope of the Santa Lucia range extends downward with but little break to the depths of the Pacific.

Off Santa Barbara the plateau rapidly widens, and its outer margin is marked by the Channel Islands. Still farther south it attains a width of 150 miles, while the water over it is much deeper. Upon this portion of the plateau are mountain peaks several of which, known as San Clemente, Santa Catalina, and San Nicholas islands, rise above the present sea level, while others reach only part way to the surface, and are known as "banks."

An elevation of 1000 feet would connect the Channel Islands with the mainland, and that the land did actually stand at least that much higher in very recent times is shown by the presence of bones of the mastodon and extinct horse upon the island of Santa Rosa.

Many movements have affected the coast of California, and we have evidence that the land not only stood much higher than at present, but also that at one time it was at least 1500 feet lower than it is now. On the seaward face of the hills near old Fort Ross, a few miles north of San Francisco, there is a remnant of an ancient boulder beach having an elevation of about 1500 feet above the sea.

Remains of wave-cut cliffs and terraces are found more or less distinct along the whole length of the California coast. These are beautifully shown upon San Clemente

Island, where they extend up to nearly 1500 feet. San Pedro Hill, near Los Angeles, is terraced up to 1200 feet, and other finely preserved terraces are found upon the coast of Santa Cruz and San Luis Obispo counties, and ranging in height from 10 to more than 700 feet. Near Port Harford wonderful wave-cut caves occur in a resistant rock 10 feet above present high tide. On Pt. Loma, near San Diego, the elevated beaches exposed in the present cliffs are full of fossil shells.

Along certain portions of the coast the mountains extend directly down to the sea, but as a general thing they are separated from the sea by a coastal plain varying from a quarter of a mile to several miles in width. This plain was a portion of the marginal sea floor at one time, and is due in part to the leveling action of the waves, and in part to the sediments which accumulated upon this floor.

We would not have known California at the time of which we have spoken when the land was so deeply submerged. All the rich lowlands were flooded. Imperial Valley and the Valley of Los Angeles formed deep bays. The Great Valley was a vast inland sea. The Coast Ranges were broken up into peninsulas and islands, and only the loftiest points of the present islands rose above the water. Such a story sounds like a romance, but we have clear evidence that it is true.

The last thing that happened to our coast was a sinking of the land, and we are not sure but that this movement is still going on. This recent subsidence has flooded the mouths of the streams along the whole length of the State, and given rise to the present bays and tidal lagoons.

The mouths of the larger streams remained open because of the strong currents, but the waves threw up bars across the mouths of most of them. Then began the process of silting up the lagoons behind the bars, and many of these have now been turned into marshes or meadows.

None of the streams thus flooded are navigable except the Sacramento. This large river, flowing down with gentle grade through the large valley now occupied by San Francisco Bay, was drowned completely across the Coast Ranges through the Strait of Carquinez, and is now affected by the tides even to the heart of the Great Valley.

A little distance back we said that two things had determined the character of the coast of California. The first was that the land has been moving up and down, but now occupies a sort of middle position between great uplift and great submergence. The second factor was the character and direction of the mountain ranges; these are nearly parallel with the shore, but exhibit a little more westerly trend, lapping past each other *en eschelon*. The position of the mountains, then, taken in connection with the fact that the continental border is not deeply submerged, has resulted in a fairly even coast line with few good harbors. It can readily be seen that if the land were submerged 500 to 1000 feet more, as we know it has been in the past, the coast line would be radically changed and many deep bays would appear. Such a condition would facilitate water traffic, but would destroy the greater portion of the fertile valley lands which now furnish us with the main body of our agricultural prod-

ucts. As far as mining would be concerned the greater portion of the oil fields would be buried, but mining for the metals, being carried on mostly in the mountains, would not be affected.

On the whole we can say that our race has come into California at the best time possible for its expansion and development. The vast expanse of lowlands is more important to us than would be additional harbors resulting from a sinking of the coast.

CHAPTER IV.

THE CLIMATE OF CALIFORNIA.

In our geographic study of California we cannot dismiss the subject of climate with a mere statement that it rains heavily in some places and little in others; that it is warm in one part and cold in another. We want to know the causes governing the distribution of the rain, why it rains nearly 100 inches each year upon the north-west coast, and an average of only two or three inches in the basin of the lower Colorado. We want to know why it is cool upon the coast and hot in the interior. We want to find out what part latitude plays, what is the influence of the coast winds, of mountain ranges and of elevation.

In seeking to learn the climate of a country we first think of its latitude, since that is usually the most important factor. In the case of California, however, this inquiry does not help us very much. The map shows that California has a coast line nearly 1000 miles in length, reaching through ten degrees of latitude, and we would expect that its northern part, which is nearly the latitude of Chicago, would be cold in winter, and that the southern part, which reaches to about the latitude of Savannah, would be very warm, but in reality there is, near the coast, only a few degrees difference in temperature between the north and the south. Spring fruits appear first, and oranges ripen earlier in Northern rather than in Southern California. We shall have to look to the ocean, the wind

and mountain barriers for an explanation of this strange fact.

Not only is there little difference in average temperature near the coast through many degrees of latitude, but we encounter the farther anomalous fact that in the course of only a very few miles in passing along any one degree of latitude from our large valleys to the mountain uplands we go through all variations of climate from the sub-tropical to the arctic.

Now with regard to the small range in temperature as we go north or south along the coast, we know that the temperature of the ocean changes but little from winter to summer. We also know that California, being in the temperate zone, is situated in the belt of prevailing westerly winds. The temperature of the air over the ocean is determined, to a large extent, by that of the water, and since the ocean varies but little throughout the year, and the winds blow mostly from the ocean toward the land, the latter is going to be cooler in summer and warmer in winter than it otherwise would be.

If it were not for mountain barriers the cool ocean winds would sweep far inland and temper the climate of the whole State to a greater or less degree. The fact that there are mountain ranges lying close to and parallel with the coast has resulted not only in a deficiency of good harbors, but has aided in making the climate of the interior subject to much greater extremes of temperature, as well as decreasing its rainfall. By the time the winds have passed the Coast Ranges their moisture and coolness have been greatly reduced, while still farther eastward, on the opposite side of the Sierra Nevadas, the summers

are not only extremely hot, but the lack of moisture makes the region a desert.

The influence of the ocean upon the adjacent land is increased through the existence of fogs during the dry season. The fogs are believed to be due to a descending current of warm air which comes in contact with the cool water some distance off the land. The temperature of the air is thus reduced below the dew point and heavy banks of fog result. These fogs are carried onto the land by the westerly winds which blow very regularly throughout the summer season. The fog is so dense and continuous that the sun is often nearly or quite obscured for days at a time. At points where valleys or passes lead into the warm interior a strong draft is set up which often carries the fog fifty miles inland. The fog keeps the coast region moist and green longer than it otherwise would be, and thus facilitates dairying and the growth of many crops.

The ocean fogs of which we have been speaking rarely reach the Great Valley, and then only through the gap in the coast mountains occupied by the Sacramento-San Joaquin river. As a result, this valley is so protected from the ocean influence that spring opens early and the summers are long and very warm, thus favoring the full development of sub-tropical fruits.

Contrasting the Great Valley with the Los Angeles-San Bernardino Valley, we find that the latter is not shut off from the ocean winds by mountains so that the coast fogs spread over the whole of this great region. These fogs so temper the air that although so much farther

south we find that many fruits, including oranges, do not ripen as early as in the north central portion of the State.

In general, the farther we go from the ocean the greater are the extremes in temperature between night and day, between summer and winter. On the coast the daily range of temperature is often less than 10 degrees, while in the valleys of the interior it may sink to 40 degrees Fahrenheit at night, and rise to 90 degrees in the daytime.

We all know that during the summer, except for the thunderstorms in the mountains, it is very rare that any rain falls over most of the State, although the air sweeping in from the sea is saturated with moisture, as shown by the fog it bears. We can say, then, that the air of the coastal regions contains more moisture during the period in which no rain falls than it does on the average during the rainy period. Now we can legitimately ask the question, Why does it not rain in summer when the moist westerly winds are strongest? This point must be thoroughly understood if we would appreciate the climatic conditions under which we are living.

In the first place, it must not be forgotten that there is more or less moisture in the air at all times, but it is only when it is saturated that this moisture becomes visible in the form of fog or clouds. It is natural to conclude that if we have no rains in the summer when the regularly westerly winds bring in the dense fog banks, we might have no rain at all if these winds blew through the whole year. It is evident, then, that we must introduce some other factor, and in fact our rains are due to other and very different causes:

In order to have rain, air must not only be cooled to the dew point, but below that point, and the only thing which will do that is exemplified in those irregular and violent disturbances of the atmosphere which set up currents carrying the moisture laden air to a great elevation where the temperature is sufficiently low to bring this about.

If we except thunderstorms, which are due to a different condition, we can say that rain is brought about through the setting up of a spiral whirling motion in the atmosphere very similar to the dust whirl so common in warm summer mornings. The storm whirls of the atmosphere are, however, almost infinitely greater than the dust whirl, being sometimes hundreds, or even several thousand miles in diameter. These great whirls, although much larger are less severe than the tornado or cyclone of the Mississippi Valley, and are commonly known as cyclonic storms.

The most of these great cyclonic whirls which bring our rain originate somewhere in the North Pacific Ocean and move easterly or southeasterly with the prevailing air currents of the temperate zone. They are much more frequent and severe in winter than in summer, and comparatively few strike the land south of British Columbia during the summer season. As winter approaches these whirls become more frequent and move farther south until finally they encounter and pass across California. If the great cyclonic air whirl moves slowly the storm lasts for several days, and if the movement of the air within the whirl is very rapid we have the rain accom-

panied by strong winds. Because of the fact that the whirls revolve in a direction opposite to that of the hands of a clock the coming of a storm is usually marked by winds blowing from some southerly point.

With the passing of one of these cyclonic storms the sky clears and the wind changes to some northerly point and blows with greater or less intensity for some time. These cool, dry northerly winds mark the passage of an anti-cyclonic whirl in which the air currents move downward in a direction opposite to that of the cyclone, and in which the pressure of the air as indicated by the barometer is abnormally high. The storm area, on the contrary, is characterized by low barometer owing to the upward movement of the air.

Many storms which pass across Northern California fail to reach the southern portion, and they also usually decrease in intensity toward the south, so that outside of the mountain districts the southern portion of the State has a very light rainfall. The influence of mountains on precipitation is extremely important because of the low temperature of their lofty tops. In the case of many storms in Southern California which pass over the lowland regions with but a slight rainfall, when they encounter the mountains there is a heavy fall of snow or rain. It is because of this fact that we find such great differences in the rainfall in the course of a few miles.

During the summer there generally exists an area of low air pressure over the Gulf of California, and here originate the "Sonora" (so-called from the province of Sonora, in Mexico) storms which bring frequent rains to Southern Arizona and New Mexico. These storms

sometimes reach into Southern California and give heavy summer rains on the mountains and in the deserts. In fact the heaviest rainfall of the whole year may occur upon the Colorado desert in the midst of summer.

Summer thunder storms are frequent in all the higher mountain regions of the State. They are partly due to the low pressure areas just mentioned, and in part to the influence of the cool mountain tops on the upward moving air currents. They add quite materially to the summer water supply.

The sea fogs which have been discussed in a previous paragraph are not the only ones which are experienced in California. During the clear cool periods of winter a heavy blanket of fog, known as "tule fog," occurs in nearly all the lowland valleys to a greater or less extent. This generally breaks away during the day, but in the lower San Joaquin-Sacramento Valley it may last continuously for weeks at a time, completely shutting out the sun. The name is derived from its prevalence in the tule region of the district just mentioned. This fog is the result of the settling of the heavier and cooler air into the hollows of the land where the evaporation from the moist earth following the early winter rains finally produces a saturated condition.

Destructive winds of cyclonic character are rarely known in California. The most disagreeable, as well as harmful, winds occur in the spring and fall. They are dry and hot, and from their direction are known as "northers." In Southern California this wind is locally known as the "Santa Ana." During its occurrence the air is more or less filled with dust, and for this reason

is often called a "dust storm" in the drier parts of the State.

From what has preceded it can be seen, in some degree at least, how it is that California is characterized by such a great variety of climates and productions. It is a remarkable and interesting fact that a few miles travel will take one from the sub-tropical belt of oranges, lemons and figs, to the temperate belt in which apples develop their best qualities. A few miles will also take us from a region of abundant rainfall to typical deserts where nothing can be raised without irrigation. Here is to be found every transition between arctic cold and tropic heat, impenetrable vegetation of the forests of the Northwest and the barren desert of the Southeast.

CHAPTER V.

NATURAL RESOURCES.

WATER SUPPLY.—Owing to the long dry summers in California and the light rainfall in certain portions, it is realized more fully here than in the central and eastern portion of our country how much depends upon the conservation and proper use of our water resources. There are large areas in California where it is impossible for people to live and cultivate the soil, be that soil ever so fertile, without first giving attention to the development of a water supply. Even in those parts of the State where the rainfall is usually sufficient for the common farm crops, there are years in which the rain does not come, and without irrigation they would be a failure.

Rain is needed most during the spring and summer, but as we have already seen, the greater part of the yearly precipitation comes during the winter. On the high mountains this falls in the form of snow which does not immediately melt and run away, but lasts until the warm spring sun shines upon it. This helps greatly in keeping up the flow of the streams when the water is needed.

In the warmer lowland regions of the State the greater part of the water which does not soak into the ground immediately runs off and may cause serious floods. In many parts of the State it is extremely important to preserve the flood waters, and as the population increases this will become more and more necessary. There are large areas in Southern California which have almost

reached the limit of development with the present available supply of water. The great quantities of flood waters which reach the sea after the heavy rains should be stored in reservoirs for summer use, thus making possible a much greater population and wealth.

The three largest rivers of the State are the Colorado, the San Joaquin-Sacramento, and the Klamath. The use of the Colorado for irrigation in California is practically limited to the Imperial Valley and the vicinity of Yuma. The Klamath might be used in Shasta Valley to great advantage, but the most of its course is through mountains. The San Joaquin-Sacramento river, with its vast plain-like basin filled with fertile soil, and its innumerable branches heading in lofty mountains covered with snow until late in the season, is the most important source of water for irrigation of any stream in the State. The Sacramento branch of this river, occupying the northern arm of the Great Valley, carries an abundance of water for all the future needs of irrigation upon the adjoining slopes, and in addition possesses a navigable channel as far north as Red Bluff. The San Joaquin and other streams of the southern arm, while traversing as large if not larger area which will be dependent on irrigation for its full development, carry less water than will be needed.

The San Gabriel and the Santa Ana are the most important streams of Southern California, and in the summer are wholly used for irrigation. The Tejuanga river is also an important stream, as it forms the real source of the Los Angeles river which supplies the city with water. Owing to the fact that the forests have

been so largely removed by fire from the steep slopes of the San Gabriel range the San Gabriel and Tejuanga rivers run very low in the summer. Reforestation is an extremely important problem in this region. The Santa Ana river, rising in the more lofty San Bernardino range, has a better summer flow. The summer flow is further increased by the extensive deposits of boulders and gravel in the form of moraines left by ancient glaciers on San Gorgonio peak. These hold the waters from the melting snows and give them off slowly through the summer.

Owens river is the largest stream in the Great Basin, and is supplied by the melting of the snows on the eastern slope of the Sierra Nevadas. The water of this river has in part been used for irrigation, and in part gone to supply that great sheet of alkaline water known as Owens Lake. An aqueduct is now being constructed to carry a part of the water of this river 200 miles across the Mohave Desert and intervening mountains to Los Angeles. It is the most wonderful undertaking of its kind in the world.

The Mohave river is another desert stream of considerable size which rises in the San Bernardino Mountains and flows northerly toward Death Valley.

The underground water supply obtained from wells at first thought seems inexhaustible. Throughout all the valleys and lowland regions wells furnish large quantities of water. In most places it has to be pumped, but in some parts of the San Joaquin Valley, the Valley of Los Angeles and the Salton Basin, or Imperial Valley, the

water flows out of the top of the well and is known, then, as artesian water.

The underground waters have accumulated from rains falling upon the surface and slowly sinking down through the gravels and sands of the valley floor, but are really not inexhaustible. In the fruit growing districts of Southern California, where many wells have been put down, the water level is gradually being lowered, so that not only is less water obtained, but the wells have to be deeper.

We have already seen that the precipitation is greater upon mountains than on lowlands, and that much of it falls as snow. The flow of the streams is thus made more even than if all came as rain. Glaciers once covered the higher mountains of the State, particularly the central and northern portions, and left vast deposits of gravel and boulders, which further aid in the retention of the water from the melting snows. These deposits also often form dams across the cañons, giving rise to lakes which are a very important agent in equalizing the flow of streams.

Except for the Sacramento river the streams of California are of very little use for navigation. Dredging out of the channels of both the Sacramento and San Joaquin Valleys should be of great assistance to the inland development of California.

The streams of California, rising as they do in high mountains and flowing with rapids and waterfalls down to the valleys, are coming to be very important as sources of power for commercial and manufacturing purposes. There is hardly any limit to the electrical power which

can be developed from them, and which now can be transmitted to any point where we wish to use it.

SOIL.—The surface of California is marked by a great variety of soils, a fact due partly to the different conditions under which they were formed and partly to differences in the underlying rocks from which they were derived. The mountain sides and foothills where the slopes are not too precipitous are covered with a soil derived from the underlying bedrock. This is known as *residual soil* because it is what remains when the constituents of the rocks decay and crumble. These soils are, as a rule, quite thin, with here and there masses of rock projecting up through them. Although fertile, and extensively cultivated, residual soils are not as deep or as rich as the valley soils. Where it is too rocky and the surface is too steep, these soils are devoted to grazing rather than to agriculture. This fact illustrates the control which physical conditions exert upon life.

For ages the rocks of the highlands have been crumbling and the streams have been carrying the finer and richer particles, as well as the soluble constituents, to the valleys or the ocean. The valley soils are therefore deep and extremely rich in plant food. In some portions of the San Joaquin, Imperial, and other valleys, there are such large quantities of soluble materials, which are usually known as alkalis, that it is difficult to raise crops without first neutralizing or removing a portion of the alkali. Such soils were formed in the beds of ancient lakes or marshy flats where the waters as they dried up left the substances which were in solution mixed with the silt.

The soils of the valleys vary with the conditions under which they were formed. There is (1) the fine alluvium of the flood plains which is very rich and sometimes hundreds of feet deep. Such a soil is well shown in the banks of New river, which cut a deep channel across the Colorado Desert (Imperial Valley) at the time of the last overflow of the Colorado river. The banks are in some places 80 feet high, and consist of alternating layers of light and dark silt from top to bottom.

The major portion of the valley slopes, particularly in Southern California, consist of coarser material deposited in form of debris fans below the points where the streams issue from the mountains. These soils, taken together with their position, offer the best conditions for the growing of citrus fruits.

The soils of the coastal region are usually a fine sandy loam. They may be confined to a narrow strip between the mountains and the sea, or as about San Francisco Bay and in the region south of Los Angeles, cover a large extent of country. The cliffs along the Alameda and Berkeley shores, as well as those at Long Beach, give good exposures of these soils.

Soils are heavy if they contain a large amount of clay, and light if there is much sand in them. Consequently, in Southern California, where the rocks are largely granitic, we find that light soils predominate, while in the valleys of the Coast Ranges and in portions of the Great Valley the soils are more often heavy and are known as "adobe" soils. The latter, while rich, are more difficult to work than the light soils.

Some plants require a heavy soil, others require a light soil to do well, and some thrive where there is much alkali, but as a rule in California the most important factors are climatic. We take into account first, then, both the moisture or water supply available, and the temperature conditions.

VEGETATION.—The belt of coniferous forests extending from California northward through Oregon and Washington is the finest in all the world, both in regard to size and the variety of trees represented. For the growth of such luxuriant forests there is needed a certain amount of moisture, as well as a given range of temperature conditions. Trees are not found in the arctic climate of the lofty mountain tops, nor in the extreme heat and dryness of the arid and semi-arid regions. The forest map of California is very interesting, for it shows how greatly the mountainous areas affect the climate, and through that the distribution of the trees. Each climatic zone, from the sub-tropical of the warmer valleys to the boreal or arctic on the mountain tops, is characterized by its peculiar vegetation. In the deserts even, where the rainfall is less than five inches annually, and sometimes a whole year passing without any rain, there is an abundance of vegetation of a certain kind. The only parts of California where to the ordinary observer there is no vegetation at all, are the summits of those mountains which rise above the timber line, the alkali sinks of some of the desert regions, and the surface of recent lava flows.

The forests are found within certain well defined limits. The upper limit, determined by the increasing cold of the

lofty altitudes, is commonly called the *timber line*. This line varies with the exposure, being higher upon a southerly slope than upon a northerly one. It also varies with the latitude, gradually rising toward the south and sinking toward the north. In the latter direction it gradually approaches the sea level, and beyond that point we find vast plains and tundras devoid of trees. The timber line upon Mt. Shasta reaches about 9500 feet. As we go toward the southern end of the State it is found higher and higher, until upon San Geronimo, the highest peak of the San Bernardino Range, which rises 11,485 feet, the timber line is barely reached. The timber line, then, is about 2000 feet higher in the southern end of the State than in the northern.

The lower limit of coniferous forest growth upon the mountain slopes is determined by the lack of moisture and is sometimes called the *dry timber line*. While there is but little of the State which rises above the cold timber line, there is a very large area which sinks below the dry timber line.

Nearly all the valleys of the Coast Ranges and portions of the Sacramento are dotted with oaks of which that commonly known as the white oak is the most abundant. As we go up the mountain slopes these finally give place to the black oak which is most abundant in the lower portion of the coniferous belt. Considering now the coniferous forest, and this is the one which is by far the most important because it forms the basis of the lumber industry, we find the trees growing at sea level from about the middle of the coastal region northward. In the drier interior the lower limit is higher, being in the

foothills of the Sierra Nevadas at an elevation of about 2000 feet. As we go southward this lower limit of the coniferous forest rapidly rises, until we find the lowest of the lumber producing trees, the yellow pine, growing at an elevation of 5000 to 6000 feet. Upon the desert slopes the piñon pine is found lower than the yellow pine, and upon the San Gabriel and San Bernardino ranges another conifer known as the big cone spruce grows in the drier zone below the yellow pine.

The zonal distribution of the different species in the coniferous forest is finely shown upon the slopes of the Sierra Nevadas. Passing through the belt of oaks we come to the digger pine. Above this is the great yellow pine belt in which are found many cedar and spruce. This zone shades into the main forest belt of sugar pine, spruce fir, and in the central Sierras the Big Trees (*sequoia gigantea*), and extends up to an elevation of nearly 9000 feet. Now we find ourselves in a forest formed largely of tamarack pine, red fir, white pine, mountain juniper, and finally alpine hemlock, and last of all, dwarf white pine.

The most important lumber tree of the Coast ranges is the redwood (*sequoia sempervirens*), which is found from Monterey county north to the Oregon line. The belt is an irregular one, the trees reaching their greatest development, near, though not directly on the coast. The most important forests are in Humboldt and Mendocino counties, where they reach back 20 miles from the coast. The sheltered cañons where there is abundant moisture contain the largest trees.

The redwoods and Big Trees are wonderfully interesting, not only for their great size and the age which they reach, some being estimated to be as much as 4000 years old, but also for their ancient history. The Sequoia is one of the oldest of tree genera, and the two California species are, with one exception, the only living representatives of a once widely distributed genus. It is probable that the Sequoia has inhabited this region for ages, since among some fossils which have been found in shales upon the coast of Monterey county there are forms which appear to represent the cones and needles of this tree. These shales belong to one of the most ancient rock formations of the Coast Ranges, and the discovery mentioned carries the genus back millions of years. It also tells us that very long ago there was a forest of Sequoias in the region of the present Santa Lucia Range.

The magnificent forests of California are clearly related to certain definite temperature and moisture conditions, and the latter are dependent upon latitude, elevation and distance from the ocean. Consequently we see that in Southern California the forest areas are limited to the higher slopes of the different mountain ranges, the most important of which are the San Gabriel, San Jacinto, and San Bernardino groups. As we go northward to the Sierra Nevadas we find a great block of lofty mountains which offers an immense area lying between the arctic cold of its crest and the warm dry expanse of the Great Valley which is heavily timbered. This belt of timber varies from 30 to 50 miles wide, and extends north

into the Cascade Range and westward through the Klamath mountains to the ocean.

We must not think that these coniferous forests are the only ones of importance in California. There remain the broad-leaved trees which although of relatively less importance than in the eastern part of our country are nevertheless of great value. The broad-leaved trees mix somewhat with the coniferous forests along their lower limit, as is shown particularly in the case of the oaks, but in general they are scattered over the drier and warmer slopes of the foothills and valleys. There are many species of the oak, among which might be mentioned the black oak, which is found in the lower edge of the coniferous forest; the white oak, which is scattered over the Sacramento Valley and the foothills and valleys of the Coast Ranges; the tan-bark oak, live oak, etc. The oaks give the valleys a beautiful park-like appearance, and add much to the attractiveness of this region. Upon the moist foothill slopes of the northern half of the State occur the laurel and madrone. The alder marks the streams in the mountains, and the sycamore is found along their courses in the central and southern coastal regions. Scattered cottonwoods occur near the streams in drier and more desert parts.

Upon many mountain slopes where there have been fires, or the soil is too poor, or the rainfall is insufficient to grow trees, there is found a growth of shrubs commonly known as chaparral. Among these are the chamiso, California lilac, manzanita, buckthorn, sagebrush, and scrub oak. Upon some mountains, particularly in

Southern California, this growth is so dense that it is almost impossible to make one's way through it.

Previous to the coming of the whites the Indians burned the surface over in order to keep down the brush so that the game might be seen. This destroyed almost all the young trees, and if it had been continued would have resulted in the final disappearance of the forests. Since the Indians disappeared there has sprung up a dense young growth of trees and brush, and the problem of protection from fire is becoming a serious one.

Fires, together with the ax of the lumberman, are fast depleting our valuable forests. The most valuable portions have passed into the hands of lumber companies which as a rule have regard only to the needs of the present, and leave the cut-over areas almost as barren as a desert. Following the destructive work of the lumbermen the rains wash the slopes, carrying away the humus and soil, and silting up our streams and bays. The long dry summers of California make it very necessary that we use every means in our power to increase the flow of the streams during this period, and irreparable damage will soon be done if we do not take energetic steps to preserve the slopes, about the headwaters of the streams, in their natural condition.

An important step has been taken by the Government in the withdrawal of all its remaining timber lands from sale, and the formation of these into National Forests. The cutting of trees on these forests will be conducted with great care so as not to disturb the surface and kill the young growth. These forests are patrolled by rangers whose business is especially to look out for fires and

protect the growth in every way from devastation. The National Forests now include nearly all the timbered lands of the State which have not passed into private possession.

In addition to the areas included in the National Forests certain other tracts noted for their scenery or natural curiosities have been set aside as National Parks. The largest and most important is the Yosemite. There are in addition to the Sequoia and General Grant parks, and in the Coast Ranges near San Francisco, Muir Woods, containing giant redwoods. The State controls one large park known as the Big Basin, in the Santa Cruz mountains, where there are many great redwood trees.

The parks are to be maintained forever as public grounds in which no trees may be cut, and in which the animals are also protected. Unless we can arouse a more general sentiment in favor of the preservation of our scenic beauties and wonders these parks, quite limited in area, are the only portions of our wonderfully interesting and attractive mountains which will pass down to our descendants unmutilated.

Those parts of the State too dry for forest growth are characterized by many peculiar and interesting forms of vegetation. Where the rainfall is not too small the valleys and gentler hill slopes are covered with various kinds of grasses, and in the spring are brightly colored by many wild flowers. Deserts cover fully one-third of the area of California, and it is in them that the most striking forms of plant life occur. The surface of the desert is usually covered with shrubs of various kinds which have become adapted to the dry hot air and small rainfall.

The Mexican creosote bush, scattered over the Mohave Desert, is a good example. Its leaves have become very small and its surface is covered with a resinous substance which prevents the evaporation of the moisture from the stems. Other plants, such as the cactus, have developed a fleshy body and spines in the place of leaves.

In the Mohave Desert there are vast groves of a tree-like yucca, and in some of the cañons upon the eastern slope of the San Jacinto mountains occurs the native Washington palm so much used in garden decoration. The mesquite, a peculiar thorny shrub bearing pods, is found growing along the desert water courses.

We find in the semi-desert valleys and lower mountain slopes a very widespread shrub known as sagebrush. There are a number of species, and one that grows to almost the proportions of a tree. The white sage, abundant in Southern California, is valuable for bees, its blossoms furnishing the best of honey.

The desert slopes exhibit a zonal arrangement of their vegetation similar to that of the high mountains. In the more arid portions of the Mohave Desert the chief shrub is the Mexican creosote bush. Upon higher slopes, where the rainfall is a little greater, we find the yucca. Ascending the slopes of the low mountains we come upon the desert juniper. Upon the higher mountains we finally reach the scrubby piñon pines, and wherever there are any mountains with sufficient height and rainfall we may look for yellow pine.

The rainfall of the desert is very irregular in time of occurrence, as well as in quantity. It would be impossible for the desert shrubs to exist if they had not become

wonderfully adapted to going without water, for sometimes two years pass without any rain. Then, again, at times during the summer, heavy thunderstorms, which we call "cloudbursts" because of their severity, flood miles of country with water. In the desert we have forcibly presented to our attention the important part which plants and soil take in keeping the water from running off too rapidly. Here there is little besides bare rock to restrain the water upon the mountain slopes, and it runs off in floods and leaves the surface in a short time as dry as before.

Occasionally there are spring rains which start into life innumerable seeds hidden in the sands. In the course of a few weeks the barren sandy desert is covered with a luxuriant carpet of many-colored flowers. In places their tints massed together may be seen from a distance of five or six miles. These flowers mature quickly, and with the coming of hot weather the seeds are dropped into the sand and the dried plants are blown away by the wind, and one would never suspect they had existed.

ANIMAL LIFE.—Few of us have any realization of the wealth of animal life in California sixty years ago. We have not only crowded the Indians aside and nearly exterminated them, but we have driven out the wild animals as well. We seem actuated with a desire to destroy.

Early explorers and settlers have left records, telling of the variety and abundance of wild life, which almost pass comprehension. Bear, including grizzlies, abounded through all the region. Elk and antelope roamed the valleys in countless numbers, and the deer were easier

to approach than the Spanish cattle that had gone wild. At certain seasons geese and ducks almost darkened the sky.

We are not certain now that there are any grizzlies left in the State. The antelope and elk are practically gone, and geese and ducks are becoming scarcer every year. We are trying to protect the deer, but they may go the way of the other large game.

Unless every one is aroused to the importance of protecting what remains of our wild animals and birds one of the great attractions of life in the open will be gone. We must see that the laws which have been passed for their protection are enforced. The main hope lies in the education of the school children through the work in Nature Study. We must show them not only the importance of preserving our forests, but also of saving the wild things which inhabit them. We must preserve the birds and animals, not only for their economic value, but also because they appeal to our love of nature.

Many animals which wandered over the State a few thousand years ago are now extinct and are known only through their fossil remains. The most interesting remains, in the form of vertebrate skeletons, have been found in some tar springs a few miles west of Los Angeles. Among these are giant wolves, sabre-toothed tigers, horses, bison, camels, elephants, sloths, etc.

The lower animals are affected more readily by climatic changes and changes in food supply than are men, for they are not able to migrate as intelligently. Each species or group of animals is adapted to certain conditions, and when these conditions change the animals

either have to migrate, to some region where conditions are similar to those they are accustomed to, or die. From the numbers and species represented in the fossil remains referred to we must conclude, then, that there have been remarkable modifications in our Pacific Coast climate in very recent times.

The animals are distributed over the State in climatic zones as are the plants, although being able to migrate with the seasons their boundaries are not as well marked as are those of plants. The animals of the desert, like the plants of the desert, have been strangely modified to suit the demands of their environment. One of the most remarkable examples of these is the desert tortoise, which has developed two water pockets so that it can go months, and perhaps years, without replenishing its supply. It is frequently found many miles from any water.

MINERALS.—A mere description of the minerals, or in fact of any of the natural resources of the State, is not geography. It is only when we consider them in the light of the conditions under which they occur, why they are distributed as they are, and what makes them commercially valuable, that their study can properly be considered geography. A mere description of California without entering into causes and relations conveys little real information. The relations exhibited by the various geographic factors in the region which we are studying is so intimate and so marked that we must make use of them in order to make our discussion intelligible.

It is rather peculiar, conceding that the stories of great wealth of gold and silver led the Spaniards to send expeditions into Arizona and New Mexico, that they made no

serious effort to explore California with this object in view. It is also interesting to note that many exploring expeditions had visited the State without getting any hint of the riches in the gravels of the Sierra streams. "What surprises me," says Captain Sutter, after Marshall's discovery, "is, that this country should have been visited by so many scientific men, and that not one of them should have ever stumbled upon these treasures; that scores of keen-eyed trappers should have crossed this valley in every direction, and tribes of Indians have dwelt in it for centuries, and yet that this gold should never have been discovered. I, myself, have passed the very spot above a hundred times during the last ten years, but was just as blind as the rest of them."

The precious metals are generally found in mountainous regions where there have been important foldings and dislocations of the earth's crust, and where the ancient metamorphic rocks have been broken through by igneous eruptions. By metamorphic rocks, we mean such as slate, schist, quartzite, and marble. The slate and schist were once clays in the bottom of some old ocean. The quartzite was once sandstone, formed by the consolidation of sand grains; and the marble was once limestone formed from the accumulation of shells and corals growing upon an ocean reef. Heat and pressure far within the earth changed these loose and incoherent materials into the bright sparkling "metamorphic rocks."

The whole Pacific border of both North and South America is wonderfully rich in a great variety of minerals, and probably the most important cause for this is

the oft-repeated and extremely severe disturbances which this region has undergone.

During the folding and dislocation of the crust in the California region innumerable seams and fissures were formed in the rocks. Molten lavas broke through these and formed great dikes, or spread over the surface. The waters which everywhere fill the seams and crevices in the rocks were heated by the molten materials and dissolved out some of the mineral constituents of these rocks. Where the temperature was very high steam was formed, and this forced the waters back toward the surface of the ground, where they still issue in many parts of the State in the form of hot or boiling springs. As the waters approached the surface they deposited some of the mineral constituents carried in solution, and thus gave us the veins of ore which we mine in so many places. In the quicksilver regions of Lake county sulphur and cinnabar, and in one instance gold, are now being deposited in fissures of the rocks by hot springs. Minerals are also being deposited by the hot waters of the silver mines at Virginia City.

Gold is found in greater or less quantity throughout all the mountains of the State except the Coast Ranges. The larger part of the latter region is formed of rocks more recent than the period of gold deposition. It is in the foothills of the Sierra Nevadas, however, where the first important discoveries were made, that we find by far the greater quantity of gold. Here are innumerable gold-bearing quartz veins, and one great system, in particular, known as the "Mother Lode," which extends through the

counties of Mariposa, Tuolumne, Calaveras, Amador and Eldorado.

Gold was first found in the shallow gravels of the present streams, having collected there during the long ages that the quartz veins and enclosing rocks had been decaying. Searching farther, the miners discovered gold in the deep gravels of streams which long ago flowed down the slopes of the mountains. Great changes in the geography of our State have taken place since then. The Coast Ranges were largely beneath the sea at the time these ancient rivers existed, and over its bottom were accumulating the ooze made up of the remains of low forms of sea life which in the course of time was to be hardened, folded and lifted above the sea and furnish our great oil deposits. The streams of this ancient time flowing down the mountain slopes in the Sierra region gradually wore them away and the rock debris accumulated in broad, deep channels at the bottom of which were the grains and nuggets of gold derived from the quartz veins.

Following the time of which we are speaking many changes took place; the whole Pacific Coast region was lifted, the Sierra block was tilted toward the west, and numerous volcanic outbreaks took place. The streams went to work upon the steeper slopes and inaugurated the deep cañons of the present time. They cut down through the old gravel channels, and so exposed their rich gold contents.

Hydraulic mining, as the getting of the gold from the deep gravels is called, was very profitable, and was carried on until it was found that the washing down of the

gravel banks was filling up the streams, when it was largely stopped. It is not the miner, however, who is most to blame for the filling up of our streams and bays; it is rather the general destruction and erosion of the surface of the ground all over the State, caused by the cutting off of the vegetation, overstocking the grazing lands, and careless farming in general.

Silver is also one of the important minerals found in California, but it is largely confined to the mountains of the Great Basin, in the eastern part of the State. Here are great beds of limestone, and the presence of silver seems in some way related to this rock.

In Shasta county and other parts of the State there are extensive copper and iron deposits.

The most important metal found in the Coast Ranges is quicksilver. Its presence seems to be related to volcanic action and the resultant hot springs which are most abundant north of San Francisco in the Clear Lake region. The oldest quicksilver mine is the New Almaden, near San Jose.

The oil deposits of California are confined to the coastal region, where are the extensive beds already referred to as having been formed of the remains of sea organisms. These organisms are in part microscopic forms of life, and in part fish remains. Under the influence of heat and pressure within the earth the organic matter was distilled off in the form of gas and oil and collected in porous sandstones. It is only recently that the extreme importance of oil or petroleum in California has been recognized, and now this mineral product overshadows all others.

Of coal, California has little, there being a few small beds of soft bituminous or lignite coal scattered here and there. During the great coal-bearing periods this region seems not to have been adapted to the production and preservation of land vegetation.

Many mineral springs, some hot and some cold, are scattered over California. They are particularly numerous and varied in character in the Coast Ranges between San Francisco and Clear Lake, and are undoubtedly related as we have before said, to the late volcanic eruptions in this region. Mineral springs have their source deep in the earth and are hence independent of the local rainfall. Such springs might be numerous in the desert regions because of this fact, while ordinary surface springs are, as we would expect, very scarce.

Among the most interesting of the mineral deposits found in California are the salts occurring in the desert. Their presence and distribution are the direct result of definite geographic conditions. The Great Basin region is divided by mountains into innumerable valleys, each one of which is a basin in itself. There is now so little rainfall in this region that the most of these basins or sinks show no surface water, but during the Glacial Period the rainfall was so much greater that many of them contained lakes. Few of these lakes, however, overflowed their basins, and as a consequence the streams which were continually bringing to them small quantities of various minerals in solution finally made their waters quite brackish. Gypsum, common salt, glaubers salt, soda, borax, nitre, etc., were the most important of these

minerals, but their relative amounts varied in the different lakes.

As the climate became drier and the waters of the lakes shrank through evaporation the salts began to be deposited in the mud upon their bottoms. Now only a few of these lakes, such as Owens and Mono, remain, and their waters are so richly impregnated with soda and salt that these substances can be obtained in commercial quantities.

In some of the old lake beds the water still gathers during the wet season, but disappears with the approach of hot weather. Others are dry all of the time, and the salts, which were left mixed with the mud and clay in their beds, through the process which we call efflorescence, slowly come to the surface and form a crust. This is often of sufficient thickness to be scraped up and refined. Thus we get soda, borax and salt. The beds of salt existing in the Salton Sink before the formation of the recent lake from the overflow of the Colorado was undoubtedly derived from the ocean which once extended from the Gulf of California north to this region.

In the southeastern portion of the Mohave Desert there are extensive beds of gypsum and rock salt which were probably derived from salt water long ago when the region was occupied by an arm of the sea.

Large quantities of salt are manufactured on the tidal flats about the southern arm of San Francisco Bay. Salt water is allowed to flow into artificially prepared ponds at intervals until, under the influence of evaporation, the water becomes saturated and the salt begins to crystallize out.

CHAPTER VI.

PRIMITIVE INHABITANTS.

The first explorers found all parts of the State inhabited by Indians. They moved from place to place with the changing seasons and in search of food. They lived in very simple habitations usually made of sticks bent over in circular form, fastened at the middle and covered with mud or skins. They subsisted chiefly on acorns, roots and game. Along the coast, fish and mollusks were an important article of diet. They have been called in general terms "diggers," probably because of their dependence on roots. Their dress consisted of skins and woven bark fibre. They used stone implements, and made beautiful baskets. California offered in general a pleasant climate and abundant food supplies. The Indians were then without the necessity for great exertion, and were therefore indolent and lower in the scale of development than the primitive inhabitants in most other parts of our country.

The California Indians did not take kindly to the civilization offered them by the Spanish missionaries, and being unable to stand confinement in close buildings, and association with the whites, they began to die off rapidly. The passing of the Indians was greatly hastened by the influx of gold seekers and settlers, who, although the Indians were generally inoffensive, unless first attacked or injured, embraced every opportunity or provocation to get them out of the way. Indeed, sometimes they were shot down with scarcely any provocation whatever.

Now the Indians have practically disappeared from the more thickly settled portions of the State.

With the Indians nearly extinct we are just awakening to the fact that their languages, songs, and myths possess exceeding interest, and if all could have been preserved might have thrown great light upon the history of the primitive peoples of Western America. The origin of these people and the length of time they have been here are important and interesting problems to be solved.

Many stories were current during the early period of mining concerning the finding of skeletons and implements in the gold-bearing gravels which were overlaid by lava flows in the foothills of the Sierra Nevada mountains. These stories were later discredited, but a renewed study of the Indians of California, the shell mounds about San Francisco Bay, and the limestone caverns of the Sierras, have recently shown that the origin of the Indians here is indeed remote, dating back perhaps thousands of years.

Although the individuals of different tribes look much alike, yet there is a remarkable diversity in the languages which they speak. There are certain groups living side by side whose languages have almost no root words in common. Although the Indians are much more readily affected by geographic conditions than are people of a higher civilization, yet the differences between adjoining tribes are often so great that it must have taken a very long time to bring them about.

Definite evidence of a very interesting character showing the long period of time which has elapsed since the present Indians came is found in the shell mounds about

San Francisco Bay. The excavations at Shell Mound Park, and also at Ellis Landing, near Richmond, show that the bases of these mounds are below the level of low tide, that at Ellis Landing being submerged nearly fifteen feet. That this change of level is not recent is shown by the extensive tidal marshes in many of the arms of San Francisco Bay. These marshes take a long time to form through the accumulation of silt, and are built up practically to accord with the present level of the water.

The skeletons found in some of the caverns of the Sierra Nevada are believed to belong to a race antedating the present Indians, for the latter never bury their dead in caves, and have no traditions of ever having done so. Judging from all that we can gather, the earliest of our primitive inhabitants found the geography of the California region considerably different from that of the present.

CHAPTER VII.

SUCCESSIVE DEVELOPMENT OF DIFFERENT OCCUPATIONS.

It is not the object of the following paragraphs to trace the industrial development of California, for that in itself would not be geography, but rather to show how this is related to and grew out of geographic conditions. It must be borne clearly in mind that human activities, like those of all living things, are dependent upon the environment. Those operations which we carry out successfully are successful not merely because of our endeavors, but rather because they are in harmony with the physical, chemical and biological laws surrounding them.

It was nearly two hundred and fifty years after the discovery of Upper California before there was any attempt made by the Spaniards to take possession of the land and establish settlements. Then, actuated by two motives, (1) that of keeping the Russians from encroaching on the north; and (2) the conversion of the Indians, successive expeditions were sent out from Mexico until a chain of missions was established, twenty-one in number, and scattered along, either on or near, the coast from San Diego to Sonoma.

The Mission fathers came from a land where irrigation was all-important, and seeing in the new land somewhat similar climatic conditions, placed the missions where the soil was fertile and water could be easily obtained for the gardens which were to follow. It was very essential that the establishments be self-supporting

as soon as possible, for communication with Mexico, the source of supplies, was very uncertain and irregular. With the use of water the soil was found to produce abundantly, and a great variety of fruit and other produce was grown in the gardens, while their cattle, horses and sheep increased wonderfully on the broad, grassy ranges.

Settlers began to enter the country and were given large grants of land. Nearly all the coastal region, beyond which they seemed afraid to penetrate, was found well adapted to grazing, and the hills soon became covered with countless thousands of cattle.

Only such quantities of grain, fruit and vegetables were grown as could be consumed, for there was no market outside the sparse population, but the products of the cattle, such as hides and tallow, could be shipped with a profit, and so stock raising continued to be the chief industry. Spain for a long time tried to monopolize the trade of the Pacific, but the American ships which finally began to enter the Pacific and work their way up the west coast, brought so many necessary articles in trade for their hides and tallow that Spain no longer tried to enforce her claim.

Affairs remained about the same for many years, and up nearly to the time of the American conquest. A number of Americans had entered California and obtained land, chief of whom was Captain Sutter, who settled on the Sacramento at the mouth of the American river. He had been raising grain and other produce for ten years at the time of the discovery of gold, and was in a position to aid the emigrants very greatly.

During the height of the gold excitement nearly every other occupation was abandoned, but after the richest placers had become exhausted many turned toward agriculture, for all products of the soil commanded fabulous prices. From this time dates the commencement of California's great agricultural and horticultural development, although for many years progress in these lines was slow.

Stock raising increased and long remained the most important industry next to mining. It was commonly believed that the most of the valley lands back from the coast were too dry to grow anything, and irrigation on a large scale had not yet been thought of. The greatest increase of agricultural products was grain, until the Great Valley became one vast granary. Cattle and sheep continued to increase in numbers, getting their support largely from the public ranges. Sheep, in particular, spread throughout all the State, penetrating even to the most remote mountain valleys during the summers, until the country was practically devastated. Serious injury to the vegetation and to the meadows, resulting in the destruction of the soils and humus of the mountain slopes through erosion, began to be apparent. In order to make more feed it was a common habit of the herders to set fires which resulted in the destruction of untold quantities of timber. The unrestrained torrents swept the soil into the streams, valleys and cañons were choked, and forested areas became in some cases almost a desert. The results of this overstocking are still to be seen in nearly all parts of the State. Where the rainfall was

slight and the slopes steep, as in Southern California, these conditions were most noticeable.

The Government finally began to awake to the manner in which not only the stockman, but the lumberman as well, was devastating the public domain, and finally came the inauguration of the present forest policy. Extensive forest reserves, or National Forests, as they are now known, were created and from these the stock are either excluded entirely or allowed to graze in only limited numbers. The stock industry began to decline, and now the great herds and the limitless ranges have nearly disappeared.

Cattle could be driven to market and their products shipped by boat. Grain could also be shipped by boat, but it could not profitably be taken to the boats until railroads were built through the main valleys of the State, connecting both with tide water and with the East. We can find hardly any large agricultural district in the United States where waterways aided as little in the development of the country and in the transportation of crops as in California. If we make an exception of the lower Sacramento and San Joaquin rivers, and the various arms of San Francisco Bay, water transportation has aided very little in the development of California. The silting up of the streams since the early days, both because of hydraulic mining and the injury done the surface through careless agriculture and stock raising, has still more limited the use of water as a transporting agent.

The Great Valley of California is most admirably adapted to water transportation, and the time will come

when the streams will be deepened so that small boats can traverse the whole length of the Sacramento and San Joaquin arms of this valley. There are no engineering difficulties whatever in the way of the construction of a canal from Buena Vista Lake at the extreme southern end of the San Joaquin Valley northwesterly through Tulare Lake to tidewater.

The three stages in the development of the products of the soil in California are, (1) the raising of cattle on the great ranches; (2) the great grain ranches, and (3) the intensive culture, with diversified farming, of small ranches made possible through irrigation.

CHAPTER VIII.

IMPORTANCE OF IRRIGATION IN
CALIFORNIA.

It was not until the value of irrigation upon a large scale was recognized that California could start upon its modern period of development. Since this development could not have preceded the era of local and transcontinental railroads whereby a market in the East, and even in Europe, was assured we might with truth say that transportation is fully as important a factor as irrigation. Irrigation turned the fertile but dry soil into productive fields, while the railroads enabled the crops to be marketed.

Owing to the absence of summer showers, even those parts of the State where the rainfall is heavy require irrigation for the growing of garden crops. In the drier parts of the State, however, many temperate fruits can be grown without irrigation by thoroughly cultivating the soil. The successful growing of oranges and other citrus fruits requires irrigation everywhere.

Irrigation was first carried on upon a large scale in Southern California, where the extensive sagebrush valleys were for a long time thought to be valueless. Where it once required several square miles to support a few half-starved cattle we now find a network of irrigating ditches supplying water to luxuriant orchards.

Irrigation is rapidly being extended in the San Joaquin Valley and the big grain ranches are being cut up into small ones where an intensive culture will prevail. Vast

irrigating systems are now being planned for the Sacramento Valley. This is the one great valley in the State where there appears to be abundant water for all needs. In the San Joaquin Valley and in Southern California the cultivation of the countless acres of rich soil available will be limited by the water supply.

Huge reservoirs are being constructed at the heads of many streams and at available points on their lower courses to hold the water of the winter storms. These reservoirs will lessen the danger from floods and save the water for use in summer. The importance of lofty mountains for the growth of a great population in California is not always appreciated; if it were not for their cold summits, retaining the moisture in form of snow far into the summer, there would not only be less water available, but the problem of a summer supply would be much greater.

CHAPTER IX.

DEVELOPMENT OF INDUSTRIAL AND COMMERCIAL LIFE.

The manufacturing industries of California have been slow in their development, partly because of the high cost of labor and partly because of the scarcity of coal, nearly all of which had to be imported. Then, besides, pig iron has never been produced here, although several iron ore deposits are known in the State, and all that was used had to be brought from the East. Recently the fuel question has been completely solved through the discovery of extensive deposits of petroleum. This is mostly a heavy oil and particularly well suited for use in boilers.

Although manufacturing must go on increasing in importance and, notwithstanding the existence of many valuable minerals, California is destined to be pre-eminently an agricultural State. The great population which it will undoubtedly support in the future will largely depend upon the soil.

The centralization of the commerce of the Pacific Coast upon the shores of San Francisco Bay has been assured since Portola first looked down upon its great expanse from the hills upon the south.

Shut in, as California is, by mountain ranges and deserts, an extensive overland traffic never could have been developed with the means at the disposal of our forefathers. With the coming of the railroad which spans cañons, tunnels through mountains, and reaches across the deserts, the barriers which Nature placed

about California have been largely done away with. When the proposed great tunnel through the Sierras, on the line of the Central Pacific Railroad, shall have been completed San Francisco Bay will be as accessible to the interior of the continent as though the great river which was once supposed to have its source in the Rocky Mountains and flow westward into this bay, actually existed.

Southern California has been so isolated by Nature from the rest of the State by the Mohave Desert and its bordering mountain ranges that we would expect what actually has happened, namely; that there would grow up here a large city which might rival San Francisco. Los Angeles has become a great center of trade and manufacturing, and has extended her boundaries to San Pedro harbor which is being enlarged as a seaport.

The particular advantages of San Francisco lie in its great land-locked bay which offers unrivaled facilities for foreign commerce, and for its accessibility to all Northern and Central California. The growth of Los Angeles is due essentially to its position as a supply point for a large interior section, as well as to its location in the heart of a great area of rich land susceptible of a great variety of productions, and possessing a climate which attracts many thousands of visitors yearly.

San Francisco and Los Angeles can never be rivals in commerce and manufacturing. Nature did not intend it to be so, and it is to be hoped that the historic State of California will forever remain undivided, notwithstanding the physical barriers separating the north from the south.

PART II

THE DIFFERENT NATURAL REGIONS OR
PROVINCES OF CALIFORNIA.

CHAPTER X.

NATURAL DIVISIONS OR PROVINCES.

California is such a large State and has such a diversity of geographic features that, without the existence of certain natural divisions enabling us to take up a part at a time, it would be difficult to give an intelligent description. Fortunately, such divisions do exist, and while they are not everywhere sharply defined yet they will aid us very materially. Making use of the drainage and the varying character of the relief we find that the surface of the State naturally falls into seven distinct regions or provinces. These are defined as follows: There is (1) the Sierra Nevada Mountains forming one great block of the earth's crust; (2) the Great Valley lying in the heart of the State and inclosed by the Sierra Nevadas and the Coast Ranges; (3) the Coast Ranges, a complex system of mountains lying between the Great Valley and the ocean; (4) Southern California, a designation usually given to all that part of the State lying south of Tehachapi Pass, but which in the following pages will be applied to that part of this region lying upon the coastal slope. The remaining portion, including the Mohave and Colorado Deserts, belong in the Great Basin and will be discussed under that head; (5) the Klamath Mountains, occupying the northwest corner of the State, and extending over into Oregon. As we look at the relief map they do not appear separate from the northern Coast Ranges, but are in reality much higher and more rugged. The perpetual snow upon some of

their lofty peaks, their rugged slopes and deep cañons, as well as their mineral resources, cause them to resemble the Sierra Nevadas; (6) the Volcanic Plateau, distinguishing the northeast corner of the State. From its broad elevated valleys rise mountain ranges and innumerable cinder cones and volcanic peaks, most noted of which are Mts. Shasta and Lassen; (7) the Great Basin occupying one-third of the area of California. This region is distinguished by the peculiar fact, implied in the name, that it has no external drainage. None of the rain which falls in the basin ever flows away to the ocean, but is largely evaporated in its desert air. We must not fall into the error of thinking that the Great Basin is one single depression with a rim of mountains about it. It is, instead, broken up by hundreds of mountain ranges into basins of varying size and position, and varying in elevation from over 6000 feet above the sea to 278 feet below. The Great Basin occupies the eastern portion of the State, and extends its whole length.

After taking up those phases of our subject in which we can best describe the State as a whole, we shall make a detailed examination of these different provinces in the order in which they have been given.

CHAPTER XI.

THE SIERRA NEVADA MOUNTAINS.

The Sierra Nevada Range is the most striking, as well as the most important physical feature of California. These mountains contain rich stores of mineral wealth; their vast watershed supplies an almost unlimited volume of water; their forests are the grandest in the world, and properly conserved are inexhaustible; their scenery is unsurpassed, and their value as a summer recreation ground places them ahead of all other areas of the kind in the United States.

Taken as a whole, the range forms a great block of the earth's crust which has been lifted along its eastern side and tilted westward. Although the relief map shows the range swinging around westerly at its southern end and joining the Coast Ranges and continuous on the north of Mt. Shasta, yet geographers have limited it somewhat. It is customary to consider it as terminating on the south at the Tehachapi Pass, although there is no good reason why the short range known as the Tehachapi Range and extending westward to the Coast Ranges should not be considered a part of the Sierras. On the north, however, the granitic rocks of the Sierras terminate near the northern line of Plumas county, and from this point northward into Oregon the mountains are formed of lava. Consequently, beginning with Lassen Peak and including Shasta and many other volcanic peaks, we speak of the mountains as the Cascade Range. The Cascade Range is formed of volcanic materials

entirely, and its rocks are much younger than those of the Sierra Nevada.

The Sierra Nevada Range, as we have defined it, has a general direction a little west of north, with a length of about 400 miles and an average width of 80 miles. The summit of the range lies close to the side along which the fracturing and uplift took place, so that the eastern slope is short and exceedingly bold and picturesque, while the western slope, as a whole, is long and gentle, although also fully as picturesque in detail. The western slope, then, both because it includes seven-eighths of the drainage, and because there is greater precipitation on that side, includes nearly all the large streams. This fact becomes of great economic importance when we consider the vast extent of fertile soil in the Great Valley which only needs the application of water to produce abundantly. If the slopes were reversed not only would the precipitation be smaller, but the most of the water would be lost in the deserts of the Great Basin.

At the southern end the Sierra Nevada Range does not much exceed 7000 feet in elevation, Tehachapi Pass being 4025 feet. Here the southeastern face is not very high nor very abrupt, but as we follow it northward in a gently sweeping curve it becomes more lofty and imposing. This face or escarpment west of Owens Valley is not equaled for length, height and ruggedness by anything else in North America. The eastern front of the Teton Range, upon the borders of the Yellowstone Park, alone compares with it in scenic grandeur.

Owens Valley has itself an elevation of 4000 feet above the sea, but the escarpment rises 10,000 feet above it, culminating in jagged peaks, the highest of which is Mt. Whitney, 14,501 feet. As viewed from the summit of the Inyo Range, lying on the opposite side of Owens Valley, the individual peaks do not stand out distinctly, and we get a full realization of the mighty Sierra wall, which, now of course much eroded, was originally formed by a two-mile vertical displacement of the earth's crust.

North of Owens Valley extensive flows of lava have been built up against the range so that the escarpment does not appear so high, but as we approach Mono Lake, which lies in a basin caused by the sinking of the earth, we encounter another great escarpment more than a mile in height, Mt. Dana rising about 7000 feet above the waters of the lake.

As we continue to trace the Sierras northward and approach Lake Tahoe, we find that the one great line of fracture and displacement of the earth gives place to three. The main eastern wall is well shown along the western side of Carson Valley. The western one forms the rugged mountains rising above Tahoe. The lake itself occupies a sunken block, and is directly due to a great flow of lava which formed a dam across the depression. This is the largest mountain lake in the State, its surface having a height above sea level of 6225 feet, and a depth of 1635 feet. The scenery, pure water, and pleasant summer climate make the region prized as a place for summer recreation.

Tracing the Tahoe Valley northward we pass a number of glacial lakes, among which are Donner, Independence,

and Weber, and finally reach Sierra Valley. The lakes drain easterly through the Truckee river into the Great Basin, but Sierra Valley, lying in the same dropped earth-block, empties westward through the Feather river into the Sacramento. In following the Sierras northward to this point the crest of the range, or line of highest peaks, has formed the divide between the Pacific and the Great Basin, but Sierra Valley is some miles east of this crest, and the drainage, instead of going eastward, as we should expect, is west through the crest by means of Feather river, as before stated. It is difficult to explain this anomaly unless we assume that the crest has been slowly rising relatively to Sierra Valley, and the streams once established maintained their courses by continually deepening their channels. Going north and east from Sierra Valley we gradually rise until we reach the top of the eastern escarpment of the Sierras and look down 3000 feet upon Honey Lake Valley, lying in the Great Basin.

How different, then, are the opposite sides of the Sierra Nevadas. Looking at the range from the east we face a bold fault escarpment. Approaching it from the west we can at only few points get a glimpse of the summit, and have to travel many miles through gradually rising valleys and mountains before we get a good view of the summit.

Mountain Passes.

For more than 200 miles along the middle Sierras there are no passes much lower than 11,000 feet, while scores of peaks approach 14,000 feet in height. This continuity of the lofty crest is quite remarkable, and made access

to the fertile valleys of California very difficult for the early emigrants. Because of this fact Fremont and party nearly perished; many of the Donner party died; and the Death Valley party were blocked and had to turn southward. Wagon roads were finally built over the Donner and Carson Passes, but on some of the other routes there were places where the wagons had to be taken apart and let down over precipices with ropes.

The first railroad was built over the Donner Pass, but owing to the elevation of 7000 feet there has always been much trouble with snow. Beckwith Pass, leading from the Great Basin to Sierra Valley, is one of the easiest passes in the range, having an elevation of only 5000 feet, but in this case we have an interesting illustration that it is not always the crest of the range that is most difficult to pass, for Feather river, the outlet of Sierra Valley, could not be followed down to the Sacramento Valley owing to the fact that it flowed much of the distance through precipitous cañons.

Until recently the highest pass occupied by a wagon road was Sonora Pass, 9624 feet in elevation, but now the State has opened a road through the Yosemite Park, Tioga Pass and Leevining Creek to Mono Lake. Tioga Pass has an elevation of 9941 feet, and is open for travel only three to four months each year. Mono Pass, near the head of the Tuolumne river, was much used by the Indians in crossing from the east to the Yosemite Valley. Mammoth Pass leads from the head of Owens river to the North Fork of the San Joaquin river, and is occupied by an important trail. Owing to the easy approach to

this pass from the east it may some time be used by a railroad.

Perhaps the easiest of all is Walker's Pass, across the southern Sierras to the valley of the South Fork of the Kern river, which has an elevation of 5280 feet. Here, however, the same difficulty is encountered as in the case of Beckwith Pass, for the Kern cannot be followed down to the San Joaquin Valley owing to the ruggedness of the cañon.

The Tehachapi Pass is approached very easily from the Mohave Desert, on the south, but the descent to the San Joaquin Valley, on the north, is so rapid that the construction of a railroad across it was quite a difficult undertaking. The old stage road from Los Angeles to Bakersfield made use of the Tejon Pass, which is situated between the Tehachapi Range and the San Emegdio Mountains. This is the easiest route connecting Southern with Central California, since in reaching the pass from the south the Mohave Desert is skirted instead of crossed as in the case of the road leading to Tehachapi. The Tejon Pass is interesting because it is situated directly on the Great Earthquake rift, and is in reality due to the presence of the rift.

Geographical Story of the Sierra Nevada Mountains.

The Sierra Nevada Mountains are noted for many things: for their mineral wealth, their forests, their lofty peaks, and their wonderful cañons, lakes and waterfalls. To understand these we must learn something of the history of the region, and this, when we know how to decipher it, can be read in the character of its surface.

We must recognize, to start with, that mountain ranges are not permanent features of the earth. They begin as the result of disturbances within the earth, finally attain their greatest height, and are at last worn down through the crumbling of the rocks, and the removal to lower lands of this waste material through the agency of running water and glaciers. We have here in California different mountain groups representing various stages in this process of upbuilding and wearing down. We shall also see that the particular stage of development in which we find a mountain range determines its economic importance to the district about.

As one ascends the long gentle western slope of the Sierra Nevadas he is constantly reminded of a region of low relief which has been lifted and tilted and is now undergoing erosion. Long ago, then, the Sierras had been worn down so that the streams flowed through broad valleys, while the highlands along the divides rarely, except in the loftiest part of the range, approached the dignity of mountains. This old surface is shown better in the basin of the upper Kern river than in any other part of the mountains. The Kern Cañon is about 2000 feet deep and bordered by distinct shoulders with plateau-like tops which slope back gently to the lofty mountains on the crests of the main range of the Great Western Divide, a spur from this main range. This plateau once formed the bottom of the valley through which the ancient Kern flowed before the mountains were uplifted. Since this last movement the cañon has been cut, and glaciers have modified the mountains along the divides, until through the action of sapping by the cirques they

have been made very rugged and precipitous. The view from some lofty point near the Yosemite Valley shows a similar condition of the surface. The valley appears as a deep precipitous cut in a rolling plateau which slopes from the San Joaquin Valley to the summit of the range. The present Sierras, then, show three dominant topographic features, namely, the deep cañons, the plateau-like shoulders bordering them, and the lofty glacier sculptured divides.

That portion of the Sierras which is at present the highest, namely, the Kings-Kern-Kaweah divide, was also the highest in ancient times. Toward the north the range was low, and during the accumulation of the gravels of the ancient streams was nearly buried by these and the later volcanic materials.

Finally there came a time when the movements of the earth's crust opened anew the fissures along the eastern base of these ancient mountains, and lava and streams of volcanic mud, similar to that which destroyed Martinique, flowed down many of the valleys and buried the river beds. The volcanic material was particularly abundant in the northern portion. Severe earthquakes undoubtedly occurred, and the mountains began to rise and tilt toward the west. In this way arose the steeper slope in which the streams finally eroded cañons 2000 to 3000 feet deep.

The Scenic Features of the Mountains.

The origin of the Yosemite Valley has been the cause of a great deal of speculation ever since it was known. There is, however, nothing which distinguishes it from

the Hetch Hetchy Valley, the Kings, and the Kern river cañons, save that it is deeper and more precipitous. All of these cañons had the same origin. The agent which produced them was chiefly running water, although their last shaping was due to glacial action. The reason that the Yosemite Valley is more precipitous and picturesque than the others is because the granite here is cut by seams or joints which are predominantly vertical, or nearly so. The rocks decay along these seams, and as their material is removed by water, cliffs finally result.

Waterfalls have originated chiefly through the difference in rapidity of erosion of a small stream as compared with a large one. The Merced river cut down into the granite so much faster than Bridal Veil or Yosemite creeks that waterfalls of great height and beauty were finally formed. The Merced river itself enters the valley by two falls, the lower one of which is due to a hard rim of granite, and the upper to the fact that at the melting of the glaciers the stream was pushed out of its old channel and forced to take a new one, over a cliff.

The glacial period was of great importance to California. The increased precipitation led to the formation of the numerous lakes in the Great Basin which are now generally dry, and from whose beds we obtain salts of various kinds. In the mountains the Glacial Period was most noticeable. The glaciers scraped off all the loose and disintegrated rock materials, leaving the surface bare and smooth, and carried this material to the end of its ice tongues in the cañons, where water, in its turn, continued to transport the gravel and boulders on toward the valley. After the melting of the ice it was a long

time before vegetation again spread over the surface, and there are large areas where the trees are only just getting a foothold in the crevices of the rocks.

The removal of the rock debris from the surface was very bad in one way, since it allowed the rains and the water from the melting snows to run off rapidly, thus increasing floods and making the streams lower in the summer. This effect was partly counteracted, however, by the morainal materials which were left in great piles and ridges here and there. This material acts as a sponge, absorbing the melting snows and allowing the water to go off slowly in form of springs.

It was for the creation of the lakes that we have the most to be thankful to the glaciers for. The hundreds and almost thousands of the glacial lakes not only add immeasurably to the scenic features of the mountains, but they are of very great economic importance. They tend to equalize the flow of the streams, and hold back large quantities of water which then runs away gradually through the summer. A study of the floods of our country will show that those streams which have many lakes, and an abundance of lakes is always found in recently glaciated areas, seldom have floods which do any great damage. Compare the upper Mississippi and the Ohio in this regard.

The glacial lakes were formed in two different ways. In one case the debris left by a glacier made a dam across a cañon and a body of water formed above. Such lakes may be quite deep, and are generally found near the terminations of the glaciers. Rock basin lakes are as a rule higher upon the mountains, and sometimes occur in

step-like series, even to the very head of the stream, the last one occupying a cirque under the precipitous walls of the crest. Previous to the coming of the glaciers the rocks had everywhere decayed to a considerable depth, this being much more pronounced in some places than in others. As the glaciers passed down the slopes and into the cañons they scraped off the soft and more or less loose rock material, finally tearing away portions of the solid rock where it was projecting in its path, and lastly grinding and polishing the surface. Where the rocks were decayed deeply basins were formed, the more resistant rock below causing the glaciers to rise and ride over it until another softer spot was found where it again scooped out a basin. We may say, then, that while the glaciers modified the cañons, they did not originate them. The real agent was running water.

We do not know, with any certainty, the cause of the Glacial Period in California, or whether it corresponded exactly with the period of glaciation in the northeastern States. We know, however, that about the time of glaciation the whole Pacific Coast region stood much higher above the sea than it does now. An elevation of 3000 feet would again cause extensive glaciation in the Sierra Nevadas, as would also a comparatively slight increase in the amount of precipitation. Small glaciers still exist on the protected slopes of the highest peaks.

The southern limits of the ancient glaciers in the Sierras was just above the lakes in Kern river cañon, at an elevation of 6000 feet. As we go northward the indications of glaciation reach lower, and in the Hetch Hetchy region was something less than 4000 feet.

The Economic Importance of the Sierra Nevadas.

The Sierra Nevada Range is now in the stage of geographic development in which it is of the greatest economic value, as well as of scenic attractiveness. If it were older there would be less of the plateau-like upland remaining, and it is this which supports a large proportion of the forest. If the range were more nearly worn down the precipitation would be less, the climate warmer, the run-off of the water more rapid, and less remaining for use in the summer. The streams, also, are at a stage where they will produce a large amount of power for commercial purposes. As we shall see later the San Gabriel Range of Southern California has reached a stage of development in which there are practically no agricultural lands available. In the Sierra Nevadas there are agricultural lands upon the plateau-like shoulders between the cañons, and at many points in the cañons themselves where erosion has resulted in producing valleys of considerable size. Several of the larger valleys in the northern Sierras, such as Sierra and Indian Valleys, are not the result of erosion, but of faulted and displaced earth blocks.

Mining was the industry which first brought this region into prominence, and the population was for a time very large. As placer mining decreased people drifted away, and the region is dotted with almost abandoned towns. The most important of the old mining towns remain, drawing their support largely from quartz mining. Those along the Mother Lode include Mariposa at the south, then Coulterville, Sonora, Angels Camp,

San Andreas, Jackson, Plymouth and Placerville, and farther north Grass Valley, Nevada City, Oroville and Quincy were once important places.

The gold of the ancient river beds is far from being exhausted, but hydraulic mining has largely ceased owing to the damage done by the tailings to the valley lands. One can travel for miles in Nevada and Placer counties without being out of sight of abandoned placer and hydraulic diggings. Thousands of acres of land once valuable for agricultural purposes is now given over to rock heaps. Much dredging for gold is now being carried on in the bottom lands of the Feather river, below Oroville, and it is proposed to dredge large areas along the Merced river below Merced Falls. Although much gold will undoubtedly be obtained, yet it is certain that in the long run the loss of these fertile bottom lands will be greater than the profit in gold taken out.

Quartz mining is of a more permanent character than either placer or hydraulic mining, and does not injure the surface to the same extent. Some of the mines on the Mother Lode are down over 3000 feet and are still obtaining a fair grade of ore.

Dairying is a profitable industry in many of the upland valleys, particularly of the northern Sierras. Sheep are now kept out of many parts of the mountains, and the number of cattle which are allowed to graze in the National Forests is limited. It is of the utmost importance that we take the best care of the watersheds of our streams, that our summer water supply may not be affected.

The forestry question in the Sierra Nevadas is of the utmost importance. We have here one of the finest timber supplies remaining in the world, and it behooves us to take good care of it. So much of the timber has passed into the hands of corporations who take no care in their lumbering operations that the solution of the problem of conservation is difficult.

The timber in the National Forests is cut under the supervision of the rangers; only mature trees are felled, and the refuse, which ordinarily adds so much to the danger of fire, is burned. When the white people first came much of the lower timber belt had an open park-like character, owing to the fact that the Indians frequently burned off the surface to keep it clear so they could hunt. This has now largely grown up to trees and brush; in fact the young timber will in a few years be an important source of lumber. Those who advocate the burning of the country as the Indians did forget that this burning killed all the young trees, and if it had been kept up would in time have resulted in the almost total destruction of the forest. In past years there has been the most criminal waste of this magnificent forest. In order to stop it entirely, and also lessen the danger of fire, the Government should supervise the cutting even on private lands. The devastation which the most of the lumber companies leave in their operations makes it necessary that we do something at once.

The water power available in the numberless streams of the Sierras is of great magnitude, and the development of transmission lines makes it possible to transport this

power to any point in the State, instead of having to use it on the spot, as in past years.

The same water, after having supplied power, can be utilized for irrigation in the Great Valley. We might with truth say that the water furnished by the Sierra Nevada Mountains is one of the most important assets of California. Hundreds of thousands of acres of rich land in the Great Valley would remain comparatively useless if it were not for this water. There is little doubt that every particle available will eventually be used, particularly in the San Joaquin Valley. We also see that the Sierra water, taken from Owens river and the eastern slope of the Sierras is destined to enable Southern California to support a much larger population than it otherwise could. The 200-mile aqueduct built at enormous expense shows the importance of the water supply for the drier parts of California.

In our description of the Sierra Nevada Mountains it will not do to pass over the use of this region as a summer recreation ground. The value of the mountains for this purpose cannot be overestimated, and it is being appreciated more every year. There is no region in the United States better adapted to outings for health and recreation. The absence of rain, except for occasional thunder storms, the bracing air of the forests, and the magnificent scenery, make these mountains more valuable for our health and happiness than for many of the so-called economic uses. The heat of the interior valleys in summer, as well as the cold fogs upon the coast, turn people in the direction of the mountains.

The public parks, such as the Yosemite National Park, will be forever kept in their natural wild state, and here the birds and animals are to receive equal protection with the forests. It is to be hoped that a much larger area than the parks will be preserved as Nature made it, for looking at the question even from a commercial standpoint, there will eventually be more money left in California by tourists and visitors, than if we cut away the forests, sell their products and leave the mountain slopes desolate and exposed to erosion by the winter storms.

CHAPTER XII.

THE GREAT VALLEY PROVINCE.

GENERAL CHARACTERISTICS.—The Great Valley deserves our attention next because it lies at the foot of the Sierra Nevada Mountains, in the very heart of the State. Its vast stretches, now but sparsely settled, will some time hold the bulk of the agricultural population of California.

The Great Valley is practically a plain 400 miles long and 50 miles wide. It gradually rises through foothills to mountains which inclose it on all sides. The northern arm is known as the Sacramento Valley, the southern as the San Joaquin, and each is drained by a river of the same name. These two streams coming from opposite directions unite in the western center of the valley and flow westward through the Strait of Carquinez to San Francisco Bay.

The Great Valley is one of the oldest of the present existing physical features of California. It was formed far back in the history of the earth through a down-folding of the earth's crust. It has been either a valley somewhat as it appears today, a brackish or fresh-water lake, or an arm of the sea throughout the long time during which the Sierra Nevadas were being uplifted and worn down, while volcanoes and lava flows were forming the volcanic plateau of the northeastern portion of the State, and while the Coast Ranges were being folded and dislocated in earthquake movements, and the ocean

was invading their valleys or retreating from their present shores.

For long ages rock waste brought by the streams from the inclosing mountains has been accumulating in the bottom of the Great Valley. Wells put down 3000 feet fail to reach the bottom of these deposits, and the process is still going on. To permit of this accumulation we must understand that the valley bottom has been slowly sinking relative to the mountains.

DRAINAGE.—The combined Sacramento-San Joaquin river was once a stream of considerable length flowing down through San Pablo and San Francisco Bays and out through the Golden Gate. Owing to the recent sinking of the coast this river was so completely drowned that but little now remains. Tidal influence is now felt as far inland as Sacramento and Stockton. Another effect of the subsidence was the flooding of the lower part of the Great Valley, so now at the junction of its two rivers there is an extensive delta and marsh region which is more or less overflowed during the spring freshets. This region is slowly being made into dry land as a result of the deposition of the silt brought down by the muddy waters. The surface is more or less overgrown with tules. Large areas have been reclaimed by levees and are found to be exceedingly productive.

The channel of the lower Sacramento river has for many miles been built up, making its immediate banks higher than the country lying back, so that in flood time the banks are dry, while the country on either side is occupied by vast bodies of water. While the immediate effect of the silt brought down from the hydraulic mines

was to shoal the beds of the Sacramento, Yuba, Feather and other rivers, yet the ultimate effect might be made very beneficial by turning the silt-laden waters into and reclaiming the marshy lowlands.

When the gold miners first came small boats could ascend the Feather river to Marysville, and the Sacramento as far as Red Bluff, but these streams have been so filled that now they are scarcely navigable above the city of Sacramento. The San Joaquin carries less water and has been used less than the Sacramento, although with a little dredging it would be navigable as far up as the mouth of the Merced.

The Merced, Tuolumne, Stanislaus, Mokelumne and Cosumnes rivers have cut well defined channels below the level of the valley on their way to their junction with the San Joaquin. Farther south the Kings, Kaweah and Kern rivers, carrying at most seasons a volume of water which is relatively less in relation to the quantity of sand and silt which they are bearing along, have built up extensive deltas above the level of the valley. A study of the map will show that these streams, with their many channels, some of which are used one season, some another, have a true delta character. Like the streams of the arid region at flood time their channels are often higher than the adjacent land, so that their waters are forever changing their course.

The streams which flow into the San Joaquin Valley from the Coast Ranges are small, and dry up in the summer, while those from the Sierras are large and numerous. The consequence is that the main drainage lines of the San Joaquin Valley are forced over toward

the west side by the delta accumulations on the side next to the Sierras.

The Kings river has built so large a delta or debris cone as to block the once continuous drainage of the San Joaquin Valley, and behind the dam thus formed there once existed a large permanent body of water known as Tulare Lake. In late years so much water has been used in irrigation that the lake has at times completely dried up, although now (1910) there is a considerable body of water there.

The Kern river, in building its debris cone, formed another low dam across the valley, giving rise to Buena Vista and Kern Lakes at the extreme southern end of San Joaquin Valley. At times of high water Buena Vista Lake discharges northward into the Tulare basin, and also southeastward into Kern Lake. An old beach with clam shells on it in the edge of the hills, 200 feet above Buena Vista Lake, tells us that once a large lake occupied the whole southern end of the San Joaquin Valley.

CLIMATE.—As a result of the Coast Range barrier the western sides of both the San Joaquin and Sacramento valleys are much drier than the eastern, and consequently much more in need of irrigation. In the former no permanent streams flow eastward from the Coast Ranges, the main drainage lines, as in the case of the Sierras being westward. Much of this land will bear grain crops on average years, while other large areas are very dry, with only a scanty vegetation, and suitable for grazing during the spring months.

Cottonwood trees are scattered over the deltas of the Kern and Kaweah rivers, and near the mountains the

latter delta contains some oaks, but generally the Sacramento Valley is destitute of trees save for narrow fringes along the streams. At Bakersfield the annual rainfall is only about six inches, but this increases northward until at Red Bluff it is twenty-five inches. Owing to the heavier rainfall a large portion of the Sacramento Valley is dotted with oaks. Some of these reach a great size, and in places give the country the appearance of a natural park.

The climate of the Great Valley is marked by much greater extremes than is the coastal region. The summers are very warm, but as the air is dry the high temperature is more easily borne than is much of the summer weather in the Eastern States. The winters are scarcely any cooler than those in Southern California, so that the citrus fruits are grown in perfection. Experiments have shown that an orange belt extends practically the whole length of the eastern side of the valley from Bakersfield to Oroville. The climatic conditions are particularly favorable for oranges where the valley merges into the lower foothills. It is a peculiar and interesting fact that oranges ripen a month to six weeks earlier at Oroville than in Southern California. This is probably due to the fact that the fruit belt of Southern California is not shut off from the ocean by lofty mountains as is that of Central California. The cool winds penetrating far inland in the former make the growth of fruits slower. We find another illustration of this fact in the Vaca Valley region lying on the western side of the Sacramento Valley and close under the Coast Ranges. Here such fruits as cherries, apricots, etc., are produced

earlier in the spring than in any other portion of the State.

Another peculiar feature of the Great Valley, and one which is not always pleasant, is the existence of winter fogs which, from their prevalence in the tule covered delta region, are known as "Tule fogs." Occasionally during the clear cool weather of midwinter these fogs spread over the whole valley.

INDUSTRIAL DEVELOPMENT.—It was at one time thought that the vast semi-arid plains of the San Joaquin Valley were only valuable as stock ranges. Then grain was sowed, but produced little in dry years. The country was desolate in the extreme. There were few comfortable homes and almost no gardens.

With the introduction of irrigation all began to change. The large ranches were cut up into small ones which were much better taken care of and produced a better living. What irrigation will do is shown in the thousands of acres of vineyards, orchards and alfalfa fields spread over the delta of the Kings river.

The greatest development of the orange industry up to the present has taken place about Porterville. Not only is the climate much like that of Southern California, but the scenery is very similar. Unlike the most of the western slope of the Sierras the valley lands here extend up to the very base of lofty mountains whose snow-covered crests are visible from the orange orchards.

Irrigation is now being extended to the Sacramento Valley on a large scale, and many of the formerly unimproved grain and stock ranches are being cut up and supplied with water. Important reservoirs are being

built in the mountains to conserve the flood waters for summer use. The most important of these is on the upper Pitt river, which rises in the remote northeastern corner of the State.

Since the Great Valley is mostly underlaid by very recent accumulations we would not expect its mineral resources to amount to much. A small bed of coal occurs at Ione. At Lincoln are deposits of clay which are being utilized for tiles and pottery. Natural gas has been found in deep wells at Stockton, and is abundant in the vicinity of the oil deposits. Artesian water is found at many points in the lower portion of the San Joaquin Valley.

The one important mineral substance which occurs upon the borders of the southern San Joaquin Valley is petroleum. The fields have increased in extent and importance until this region has become the great oil center of the State. The important fields are the Kern River, Coalinga, McKittrick, Sunset and Midway. The latter is of the greatest extent, and in the spring of 1910 occurred the wildest excitement ever known since the first discovery of gold. In the Sunset field is the greatest oil well in the world, which for several months spouted oil into the air at the rate of over 40,000 barrels every twenty-four hours. The oils here are better suited for fuel than for illuminating purposes. Large quantities of gasoline, distillate and lubricants are produced in the refining process.

The cultivation of the soil in the Sacramento Valley was first undertaken by Captain Sutter, who obtained a grant from Mexico and built a fort near the mouth of

the American river. Shortly after the discovery of gold General Bidwell planted orchards near the present town of Chico.

All those who set out orchards during the early days of the gold excitement, mastered the climatic conditions which were so different from the East, and successfully applied irrigation, received almost fabulous prices for what they could raise.

Geographic conditions were all-important in determining the locations of the first towns. Sacramento early became the main center for distribution of supplies to the miners because boats of large size could readily ascend the Sacramento river to this point. Before hydraulic mining caused a shoaling of Feather river, boats ascended as far as the present city of Marysville. This fact determined the location of the place. Red Bluff owes its location to the fact that boats could ascend the Sacramento to that point.

Sacramento, in addition to being a supply point for the mines, was also the terminus of the overland route, so that nearly all the emigrants arriving by wagon team went there first. The place also became the terminus of the first overland railroad, and later an important railroad center. It is now an important shipping point for early fruit and vegetables destined for the East.

Stockton also grew up as a town because of its relation to water transportation. Supplies were sent to the southern mines from this point, but as the mines became less important its position with regard to a vast and fertile agricultural region has become the determining factor in its destiny.

The position of both Bakersfield and Fresno were determined in a general way by the delta lands of the Kern and Kings rivers, respectively. In a region which is as dry as a large part of California the presence of an abundance of water is one of the first considerations in the location of the towns and cities.

There is no more fertile and easily cultivated region in the world than the vast area of marsh and overflow lands lying at the junction of the San Joaquin and Sacramento rivers. The character of the soil, together with the abundance of moisture, particularly adapts this region to the growing of vegetables. The lands have to be protected with dikes or levees, but during severe floods these are frequently broken down. Studies are now being carried on as to the best methods for taking care of the flood waters of this region and filling the marshes. Investigations are also being made as to whether this region is rising or sinking.

The Great Valley of California is most exceptionally situated for the support of a great population. It is rimmed with mountains from which the drainage lines descend and converge at one point. From this point, at the strait of Carquinez, there is communication with the whole world by deep-water vessels. Large sailing vessels can come up through the strait and receive their loads at the very door of the valley. When the Sacramento has been deepened to Red Bluff, and the San Joaquin dredged and a canal built from it to the Tulare and Kern basins then this great region will be prepared to begin its boundless development.

In addition to this possible water transportation the Great Valley is at present connected with the rest of the country by four important railroads which make use of depressions or passes in the rim of mountains. On the east Donner and Beckwith passes are used. On the south Tehachapi, and on the north the Sacramento river cañon gives access to the northern part of the State, from whence Oregon is reached by the Siskiyou Pass. There are other passes, as we have seen, which will doubtless be used as the population increases.

CHAPTER XIII.

THE COAST RANGES.

As far as we can learn Fremont was the first to use the name Coast Ranges for the mountains bordering the coast of California. At that time too little was known of the geography of this region for the name to have any very exact meaning. Although in reality mountains are practically continuous along the coast from Oregon to Southern California, yet, as far as our State is concerned geographers have come to apply the term Coast Ranges much as Fremont used it, meaning that portion of the mountains bordering the Pacific Coast which lie between the Great Valley of California and the ocean.

The Klamath Mountains, occupying the northwest corner of the State, are more lofty and Sierra-like than the Coast Ranges, contain important deposits of gold and copper, and for the most part consist of older rocks. These criteria are made the basis for the demarkation between the two, which forms a pretty direct northwest and southeast line, according closely with the lower Klamath river and the South Fork of Trinity river, from the head of which it is carried across the crest of the range south of that group of peaks known as the Yallo Bally Mountains.

The Coast Ranges are limited on the south by a line drawn westerly from the extreme southern end of the San Joaquin Valley, a line which closely accords with

the northern boundary of Santa Barbara county. We find this marked topographically by the Cuyamas Valley and the Santa Maria river, and further by the fact that to the south the mountains extend nearly east and west, while the Coast Ranges have a northwest and southeast direction.

In describing the Coast Ranges we have to do, as the name implies, with a group or system of mountains in which there are a number of distinct ranges. They do not constitute a simple mountain block like the main part of the Sierra Nevadas. The folding of the earth's crust and the formation of fracture and earthquake lines in a general northwest and southeast direction have given origin to the series of parallel mountains and valleys. The disturbances of the earth's crust in this region have been many and severe, affecting now one part, now another part.

A bird's-eye view from some lofty point shows the ranges with the intervening valleys which make up the system extending a little more to the west than the general trend of the coast. This results in rocky headlands where the mountains come out to the sea, while behind the headlands, and lying at the mouths of the valleys, are bays with sandy beaches penetrating the land more or less deeply. Our bird's-eye view also shows that there are comparatively few isolated mountain peaks, but many somewhat uniform valleys and ridges which in a broad way seem quite monotonous, but when viewed in detail appear to be extremely varied and attractive. Many passes and connecting valleys break up the region into a

great complexity of features so that it is impossible to describe its geographic development as a whole.

According to the records shown in the geographic features, as well as in the rocks, no other portion of the United States has had such a remarkably complicated history. Nowhere else do we find stronger evidences of the instability of the earth's crust. One part has been folded, another has been raised or dropped along crustal fracture lines. Then, here and there volcanic action has been severe and long-continued. The region of the Berkeley Hills was quite recently occupied by a fresh-water lake, while another large lake occupied the lowland district about the southern arm of San Francisco Bay.

The geographic features have been further complicated by the movements of the land relative to the sea. At one time, perhaps, there were many such times, the land stood much higher than now, and the shore lay a varying distance to the westward of the present shore, while the streams cut channels, in some places cañons, across what is now a part of the submerged continental plateau.

At another time the Coast Ranges were submerged until nearly buried beneath the waters of the Pacific. They were then practically a group of islands and peninsulas separated from the Sierra Nevadas by a broad, deep bay which occupied the Great Valley. Earthquakes and volcanic outbreaks, and changes of the level of the land seem never to have left the country at rest. We once thought that it was at rest, and that there would be no more changes, but the great earthquake of 1906 taught us better.

It was formerly believed that the Coast Ranges were newer than the Sierra Nevadas, and that the continent grew progressively westward from the Rocky Mountains. This is a mistake, for there was extensive land here long before there was any Sierra Nevada Range. The granite exposed in the Santa Lucia, Gavilan and Santa Cruz Ranges, on the Farallone Islands and at Point Reyes, tells us there was land here long ago, and it was on this ancient land that the earliest known representatives of the Sequoias lived, as has already been mentioned.

The complexity of the geography of the Coast Ranges is increased by the fact that the underlying rocks vary greatly in their resistancy to decay and erosion. Valleys may be formed where the rocks are soft, and where they are resistant picturesque peaks may be developed as is illustrated in the case of the San Luis Buttes. These are the most striking mountain peaks, due to purely erosion effects, which we have. They represent ancient igneous eruptions which once broke up through the crust and now stand out because they are hard and the rocks around them are soft. They extend in line from the town of San Luis Obispo northwesterly to the ocean, and terminate in a great rock known as Morro Rock which rises bare and rugged to a height of nearly 600 feet.

South of San Francisco there are three prominent mountain axes. The southern one, which lies along the ocean the major part of its length, is known as the Santa Lucia. This is the most rugged of the mountains included in the Coast Ranges. The lofty points and deep rugged cañons are quite Sierra-like in character. The

main crest is about 4000 feet high, while Santa Lucia, the highest peak, reaches nearly 6000 feet. For many miles the range rises with extreme ruggedness from the ocean in which its southern base rests. The continental shelf, which borders almost the whole of California, is absent here, so that the range really has its base in the depths of the Pacific. On the south it merges into the Cuyama Range of Santa Barbara county, and on the north it terminates at Point Pinos, and forms the beautiful Monterey Bay.

The middle axis of the southern Coast Ranges is the Santa Cruz-Gavilan Range, which extends from Point San Pedro, a few miles south of San Francisco, southeasterly until it finally merges in the Mt. Diablo Range. The highest peaks of the Santa Cruz Mountains rise to 3500 feet, while the Gavilan reaches about 3000 feet. This axis is worn down in the middle, where the Pajaro river crosses it, so as to make really two parts, as mentioned above.

The northern of the Coast Range axes, and the one forming the watershed, is commonly known as the Mt. Diablo Range. The name is derived from the double peak rising to a height of 3849 feet a short distance south of the strait of Carquinez. Mt. Diablo is the most prominent landmark seen from across the Great Valley as one journeys toward San Francisco.

A western spur of the Mt. Diablo Range is known as the Contra Costa Hills, inclosing San Ramon and Livermore Valleys. The southern portion of the range lying opposite the Santa Clara Valley is the Mt. Hamilton Range, rising 4210 feet, and containing the Lick Observ-

atory on its culminating peak. In a southeasterly direction the range decreases in height, but finally rises again in San Carlos Peak, in southeastern San Benito county, to a height of nearly 5000 feet. From this point the mountain axis which we have been describing rapidly sinks, exhibiting several low passes, and finally blends with the San Emegdio Mountains south of the San Joaquin Valley.

North of San Francisco Bay we still find exhibited the northwest and southeast parallelism of the mountains and valleys of the Coast Ranges. Here Napa and Sonoma Valleys divide the region into three mountain axes. North of these valleys we can no longer distinguish such a division, and from Clear Lake on to the Klamath Mountains we appear to be dealing with one broad and topographically complex range.

The highest peaks of the Coast Ranges are found along the crest north of Clear Lake. Here Snow Mountain rises to about 8000 feet, while other peaks connecting with the Yallo Bally Mountains are nearly as high. To the southeast the Coast Ranges also blend with lofty mountains, the San Emegdio Range, one peak of which reaches nearly 9000 feet.

DRAINAGE.—The last submergence of the coast flooded the only large river of the Coast Ranges. San Francisco, San Pablo, and Suisun bays now occupy the former channel of the Sacramento-San Joaquin river. Many small streams which once entered this old river, such as Napa, Petaluma and San Pablo creeks, now empty direct into San Pablo Bay, while Alameda and Coyote creeks flow into the southern arm of San Francisco Bay.

Two other streams, which, from the general character of the relief of this region, we should judge would enter San Francisco Bay, turn before reaching it and cut directly through intervening mountain axes to the ocean. These are Russian river and San Benito river, and if you will consult the relief map you will see that they flow in opposite directions from the extreme ends of the longest valley of the Coast Ranges. This valley includes Russian river and Sonoma valleys, San Francisco Bay, Santa Clara, and San Benito valleys. The Russian river is separated by an almost imperceptible divide from San Francisco Bay, but leaves this unobstructed course and turns at right angles and cuts a cañon through the mountains to the ocean. The only explanation possible is that when the river assumed its present course the surface features must have been very different from those of the present. The course which now seems so anomalous was then the most natural one.

The San Benito river also flows, throughout the most of its course, in the direction of San Francisco Bay, but for a reason probably similar to that governing the direction of the river just described it leaves the open valley and, by means of a cañon through a gap in the Santa Cruz-Gavilan Range, reaches Monterey Bay.

There are two important drainage basins in the Coast Ranges. The largest of these is that of the Salinas river, but this fact is far from meaning that this is the largest river. A large part of this region has a very small rainfall, so that during the summer months much of its bed is dry and covered with drifting sand. Water, however, can always be obtained by digging in the sand, while

here and there it comes to the surface. Much of the area of the valley is treeless for lack of moisture, so that during the winter storms the water runs off rapidly, causing serious floods. The long bridges which span the drifting summer sands then come into use.

Much of the area of the valley land is suitable for agriculture and diversified farming. Irrigation is necessary to make this region support a large population, but as yet no effort has been made to conserve the winter flood waters.

The second largest drainage basin is that of Eel river. This contrasts very markedly with the Salinas. The rainfall is heavy, the slopes are generally more or less forested, and the surface consists of a very complex grouping of mountain ridges and deep cañons, with few valleys of any size. Round Valley and the extensive coastal plain at the mouth of the river comprise the largest agricultural areas. The different forks of Eel river drain nearly all of the northern portion of the Coast Ranges.

The Santa Maria river drains the extreme southern end of the Coast Ranges, being in reality practically on the boundary of the region as we have defined it. The rainfall, except upon the mountains, is small, and there is but little running water in the summer. The Cuyama Valley, at the upper end of the river, has a semi-arid climate and is devoted to stock raising. Near the coast fruit and sugar beets are raised, in addition to stock. In the latter section the valleys widen, giving large areas of lowlands.

The Santa Maria river, or Cuyama, as it is known in its upper course, heads in that exceedingly rugged complex of mountains from which streams flow into the Mohave Desert, the San Joaquin Valley, the Coast Ranges and Southern California. The region south of the Santa Maria river we have agreed to include in the Southern California province. We might, with just as much propriety, include nearly the whole of Santa Barbara county in the Coast Ranges, for its mountains and valleys are not separated by any distinguishing features from the region which we have been describing.

The watershed of the Coast Ranges is comparatively simple, and like that of the Sierra Nevada, lies near its eastern edge. The only exception to this is the Clear Lake basin, which is drained by Cache creek, which flows easterly, finally to empty into the Sacramento river. Clear Lake once drained westerly into Russian river, but a landslide occurred below the beautiful blue lakes, which lie in its old outlet, and the waters were turned in the opposite direction. This is one of the most remarkable examples of the reversal of the drainage which we have in California.

If the watershed of the Coast Ranges was near the coast it would supply much more water to the Great Valley, but there would be little of the moist coast area which is so favorable to dairying, and the growing of beans and other crops. As the topography exists, however, conditions favor the penetration of the cool moist air far inland, for many of the valleys lie in the direction of the prevailing winds, and open out in funnel form toward the ocean.

A remarkable feature in the southeastern portion of the Coast Ranges is the Carisa plain, a semi-arid valley fifty miles long and ten miles wide. This has no outlet to the sea, and thus resembles the sinks of the Great Basin. A shallow lake once occupied this valley, but it is now dry and in its place is a white deposit of salt and alkali. At one spot the lowering of the watershed fifty feet would drain the valley into the Salinas river basin, but the rainfall is so slight that this has never been broken through.

CLIMATE OF THE COASTAL REGION.—While the average temperature differs but little along the coast through a distance of 1000 miles, yet there is a remarkable difference in the rainfall. This is due to the fact already explained that the number and intensity of the storms increases from south to north.

The valleys of the Coast Ranges particularly favor the extension of the influence of the ocean far inland, for they are not only wide at their mouths, but also lie in the direction of the prevailing winds.

The strong summer indraft carries the cool fogs many miles into the interior, but only at the strait of Carquinez do these fogs succeed in penetrating the Great Valley, cooling the delta region to a temperature considerably lower than that of the rest of the valley.

The strongest wind draft is found in the Salinas Valley, where the ocean winds coming in from Monterey Bay finally attain almost the proportions of a gale. At the town of Salinas the wind is not noticeably strong, but increases up the valley for seventy-five miles. It reaches the little town of Bradley in the afternoon, and

blows very hard late into the night, after the wind has gone down near the ocean.

Watsonville, lying partly protected by the Santa Cruz Mountains from the prevailing westerly winds, feels so little the influence of the ocean that it has become an important fruit growing district. Apples, in particular, do well here, while they are not raised successfully where exposed to the ocean winds.

The low summer temperature and the foggy weather make the coast region an unfavorable one for the growing of such fruits as oranges, figs, and raisin grapes. Under favorable conditions, where mountains shut off the coast winds, oranges will mature and do well as far north as Santa Rosa.

Interesting exceptions to the rule that it becomes cooler as one ascends a mountain will appear all along the coast where it is bordered by high mountains. The fog mantle does not usually reach above 1500 feet, and while below this level the air is cool and damp, above it is warm and pleasant. This is well illustrated on the slopes of Mt. Tamalpais which has an elevation of 2064 feet. It is a striking experience to climb one of the coast mountains and pass all at once from the chilly sunless atmosphere to the bright warm sun and see below the great ocean of fog encircling the mountains.

This sea fog occurs only during the dry season, and is at its worst during June, July and August. Whenever, during this summer season, an area of high air pressure exists in Eastern California and Nevada the air currents are reversed and blow from the land toward the ocean, giving clear hot summer weather similar to that of the

interior. They usually last about three days, when the fog comes in again.

Sometimes, for days in succession, the temperature varies along the coast not more than 10 degrees in twenty-four hours, while in the interior there may be a daily range of 40 degrees.

Taking everything into account there is no more attractive region in the world than the Coast Ranges. The ordinary extremes of temperature, both winter and summer, are modified by the nearness to the ocean, so that not only is the climate pleasant most of the year, but it is possible to grow a great variety of fruits. Besides these things the valleys have a park-like appearance on account of the oaks, and there is in most parts water in abundance.

MOUNTAIN PASSES: LINES OF COMMUNICATION.—If we were to pick out the pass or gateway in California which is of greatest economic importance we should have to select Carquinez Strait, which permits of water traffic between San Francisco Bay and the Great Central Valley. Streams, valleys, and railroads radiate from the bay region to nearly half the State.

Unless our attention is drawn particularly to the fact, we do not realize how intimately the settlement and development of the different parts of the State have been affected by geographic conditions. While the Russians once made a settlement known as Fort Ross, on the coast of California, and held it for nearly a third of a century, they did not succeed in penetrating inland, for the reason that the mountains and valleys at that point extend parallel with the coast instead of opening out to it.

Humboldt Bay and San Diego Bay are the best two bays, excepting San Francisco Bay, and cities destined to be of great importance are growing up on each of these, but their progress has been delayed because of land barriers. Humboldt Bay and the tributary valleys are separated by a rugged and mountainous country from the rest of the State. Eureka is growing in spite of the fact that it has had only water communication with San Francisco. It is reached by stage line from the railroad which runs up Russian river valley. Now this railroad is being extended and will soon reach Humboldt Bay. Owing to the steep mountains and deep cañons there is no communication with the Sacramento Valley otherwise than by trails, but as there are large bodies of valuable timber in the Klamath Mountains a railroad will undoubtedly be built some time across this region.

Except at a few points where high mountains come directly down to the sea, there is a strip of land which we might call a coastal plain, varying in width from a fourth of a mile to several miles, along the whole coast of California. This coastal plain supports a considerable population and important industries, chief of which are lumbering and dairying. Nearly all points on this strip of land are reached by wagon roads over the mountains, but most of the traffic is by boat. Owing to the general absence of protected bays the boats are anchored at favorable points where deep water comes up close to the shore and their cargoes are taken on by a cable.

A number of passes lead across the Mt. Diablo Range, which, as has already been stated, forms the watershed of that portion of the Coast Ranges lying southeast of

San Francisco Bay. The lowest of these leads through Niles Cañon to Livermore Valley, and thence over the mountains through a low pass to the San Joaquin Valley. Farther south are the Pacheco, Panoche, Palonia, Palo Prieta, and Templor passes, none of which are much less than 2500 feet in elevation. Several of these will some time be occupied by railroads.

Owing to the rugged character of much of the coastal region the early padres experienced great difficulty in working their way northward from San Diego. The route of the exploring parties finally became the main line of travel between Los Angeles and San Francisco, and is known as the Camino Real. This route led from Los Angeles to San Fernando, thence to San Buena-ventura, and up the coast to Santa Barbara. From here the coast was followed to Gaviota Pass, an important gap in the Santa Ynez Range; then it turned inland to Mission Santa Ynez, from which point valleys were followed through to San Luis Obispo. Here the Santa Lucia Range was crossed through Cuesta Pass to the beautiful Santa Margarita Valley, on the headwaters of the Salinas river. It was an easy matter to follow the Salinas Valley down past Soledad Mission, and then over a spur of the Gavilan Range to San Juan Mission, a few miles from the present city of Hollister. From this point on north it was a mere matter of following open valleys to San Francisco.

The coast of California consists of rocky headlands alternating with long stretches of sandy beach. A study of the coast tells us many interesting things about the geographical history of this region. Changes in the

height of the land relative to the sea seem ever to have been going on. It is believed that while there were glaciers in the high mountains the land stood so much higher that the present islands were a part of the main land. Then the coastal valleys and plains were much more extensive than now, as shown by the soundings, and gave to the coast region quite a different aspect. When the land sank it went down so far that there was but little land left in what is now Western California, the Coast Ranges being cut up into islands, bays and peninsulas.

We know that the land sank to a point fully 1500 feet below the present because of the remnant of a boulder beach at that elevation near the top of the mountain ridge back of Fort Ross. We have evidence that after this the land rose again to a point several hundred feet above the present level, exposing the margin of the old coastal plain. The last sinking of the land has drowned a portion of this again, so that in places steep mountain slopes rise directly out of the sea. It is interesting to speculate upon the possibilities of agriculture in the different stages of this development.

An examination of the cliff cut by the waves along the coastal plain will show in many places remnants of the ancient sea beach, with boulders, pebbles and shells, formed when the coastal plain was a portion of the marginal sea floor.

The waves are now eating their way into the land on all exposed shores and making a new sea floor which at some future time may be uplifted to form a new coastal plain. The old levels of the sea, or terraces as we commonly call them, stand out distinctly along the coast of

Mendocino and Sonoma counties, and south of the bay region in Santa Cruz and San Luis Obispo counties.

OLD LEVELS OF THE MOUNTAINS.—Our study of the Sierra Nevada Range has shown us that long ago the mountains were low and that the streams flowed at a gentle grade through broad valleys. The watersheds were so worn down that they presented a very even sky line, with only here and there an elevation which stood out distinctly. We have unraveled a similar story in the geographic features of the Klamath Mountains and Coast Ranges. Their western slopes were buried beneath the sea up to a level 1500 feet above the present. The remaining land was low, and there were none of the present cañons, the streams flowing through broad valleys. The whole region of the northern Coast Ranges and Klamath Mountains was so worn down that the surface, save scattered elevations about the heads of the streams, had a plain-like character. The outline of this old plain can now be seen from many points in this region. A trip through it also shows many remnants of the old surface in the flat-topped ridges between the present cañons.

The central and southern Coast Ranges present more of a diversified character, and have been more broken by subsequent movements, but here and there remnants of an ancient surface of low relief can be seen. This is notably true in the case of the even sky-line forming the top of the Santa Lucia Range, and in the general character of the whole Salinas river basin, where gentle slopes and flat-topped ridges abound. Through these the present streams have cut cañons and valleys, thus adapt-

ing the slope of their beds to the present level of the land. The flat ridges are of great economic importance, particularly upon the northern coastal region, for they are exposed to climatic conditions which adapt them particularly to fruit growing.

The different stages of the uplift of the land from that time of depression and low relief are shown upon both sides of the Santa Cruz Mountains, in the form of benches or terraces. River terraces appear at many points along the Salinas, at one point six terraces, one above the other, can be counted in the hard rocks. The Arroyo Seco, rising in the Santa Lucia Range and flowing northeasterly into the Salinas, exhibits the most perfect terraces of any stream in the State.

ANCIENT VOLCANOES.—The most of the many volcanoes which once existed in the Coast Ranges have been worn away, but there still remain many extensive bodies of lava, some of which are very ancient. The last volcanic eruptions covered a large area of country between San Pablo Bay and Clear Lake, and it is on the southern edge of the latter body of water that volcanic mountains and craters still exist. Here rises Mt. Konocti, or Uncle Sam, as it is sometimes called, to a height of 4246 feet. Mt. St. Helena is another lofty peak, a few miles to the south, which has an elevation of 4300 feet, and although formed of lava, gives no indications of ever having been a volcano.

About Clear Lake are innumerable mineral springs of various kinds, some hot and some cold. At the eastern end of the lake is the noted Sulphur Bank, where sulphur and cinnabar are still being deposited from hot

springs. Borax Lake, a small body of water close under the northern side of Uncle Sam, occupies what is probably an explosive crater. On account of the presence of mineral springs, as well as a pleasant summer climate, this region is much resorted to for health and pleasure. The mineral springs are directly related to the recent volcanic activity, and show that far below the surface this is not yet extinct. It might be instructive to remark here that while in many parts of the earth the earthquakes are due directly to volcanic action, yet in this section, as well as over California as a whole, the frequent earthquakes are due to an entirely different cause.

THE GREAT EARTHQUAKE RIFT.—The Great Earthquake Rift, or San Andreas fault, as it is called in the Carnegie Report, is one of the most remarkable and interesting features of the Coast Ranges, if not of the whole world.

The rift is a fracture in the earth's crust of unknown length, and along which movements have taken place for many thousands of years. It is due to a strain in the crust, similar in some ways, although upon a much larger scale, to other rifts which have been concerned in the making of the mountains of the West.

The known length of the rift is about 700 miles, but neither end has yet been found. It appears first upon the north a little distance southeast of Eureka, in Humboldt county, and is traceable southeasterly through the Coast Ranges and finally into the Colorado Desert.

Previous to the great earthquake of 1906 a part of this line had been recognized and studied by geographers

who saw in the peculiar surface features indications of comparatively recent movements.

The features by which we have come to know the rift are low ridges and escarpments, hollows, ponds, lakes, springs and meadows. The topography has been greatly modified along this line because of the easy erosion of the broken and crushed rocks. Cañons, long narrow valleys and passes make it convenient to use the rift line for roads and trails, and this, together with the existence of springs and meadows, gives it great economic importance.

The part of the Great Rift appearing upon the land begins its main course a few miles east of Pt. Arena, where it comes in from the sea. It passes up the Gualala river cañon and over a spur of the mountains and goes into the sea a little distance southeast of Ft. Ross. It is seen again on the neck of land north of Tomales Bay, then passing up the bay traverses a long valley to Bolinas Bay. The rift passes outside the Golden Gate and strikes the land again six miles south of the Cliff House. It now skirts the eastern base of the Santa Cruz Mountains, and crossing them passes close to the San Juan Mission and along the eastern side of the Gavilan Range. From this point we trace it to the Cholame Valley, and then finally into and through the whole length of the Carisa plain. The remaining portion belongs in Southern California, and will be described later.

The earthquake of 1906 opened the northern half of the rift, making a sixteen-foot horizontal displacement near Pt. Arena. This decreased to a foot or less near

San Juan in San Benito county. The southern half of the rift opened in the great Tejon earthquake of 1857.

We might as well recognize the fact that earthquakes may happen any time along this rift, and be prepared to meet them. Earthquake movements similar to that of 1906 have been the main factor in the origin of our lofty mountains and magnificent scenery, and I am sure that with this insight we should be willing to take them philosophically.

NATURAL RESOURCES.—The Coast Ranges are distinguished from most of the other mountains of California in that they contain few deposits of the precious metals. Cinnabar, the ore of quicksilver, is the most important mineral product, unless we except petroleum. It is found in many places in the region southeast of Clear Lake, at New Almaden, near San Jose, where it was first mined in the State; at New Idria, in San Benito county, and in San Luis Obispo county. California is the one important quicksilver producing State in the Union.

Small quantities of a poor variety of coal are found at various points, the most important being in eastern Monterey county. But little is mined at the present time. The enormous deposits of petroleum, suitable for fuel, which have recently been discovered will certainly take the place of coal. We should perhaps distinguish the different origin of these two substances. Coal is in no way related to petroleum, for it required swampy or marshy areas and a warm, moist climate favorable to the growth of a luxuriant vegetation. It was further necessary, after the accumulation of a great thickness of vegetable matter, that these areas should sink beneath the

sea and became covered deeply by other rock accumulations. Petroleum, on the contrary, is formed from accumulated remains of countless organisms, the most of them microscopic, in the depths of the sea.

The chief deposits of petroleum of the Coast Ranges are in the southern part, the most important field yet developed being the Santa Maria field in western Santa Barbara county. Petroleum is also found here and there over the region between San Francisco and Santa Maria, wherever exist the so-called "bituminous shales," or oil shales which, as we have seen, were formed long ago in the deep sea. Asphaltum is the term applied to an oil which has become solid from the evaporation of its volatile constituents, while bituminous rock is a sand impregnated with a thick tar-like oil. This is quarried and used extensively for paving streets.

The distribution and importance of the forests of the Coast Ranges is dependent upon the amount of rainfall. Slope, exposure and soil also influence the growth of vegetation. Nearly all the valleys are dotted with oaks, while many of the mountain slopes, particularly toward the south, are covered with brush.

The most characteristic tree is the redwood (*Sequoia sempervirens*) which occurs in groves, whose trees are of giant size, from the Oregon line south to Monterey county. These trees occur in greatest numbers in Del Norte, Humboldt and Mendocino counties, with some extensive groves in Santa Cruz, Sonoma and Marin counties. Its natural home appears to be the moist cañons and lowlands near the coast wherever they are more or less protected from the direct ocean winds. One

of the largest of the groves in the Santa Cruz Mountains is found in Big Basin, and has been reserved as a State park. Another grove in Redwood Cañon, at the southern base of Tamalpais, has been preserved from destruction and is now known as Muir Woods.

The redwood has a remarkable vitality, and is likely to survive as an important tree for the use of our descendants in spite of the efforts of many to clear the ground on which it grows and use it for other purposes. The tree sprouts from the roots and stump, and it is almost impossible to kill it unless the stump is burned up. Much of the land on which the redwood grows is more important for growing trees than for anything else, and people should be prohibited from carrying out their foolish efforts to kill these trees.

Of limited importance, as a source of lumber, are the other trees of the Coast Ranges. There are some spruce and pine, and oak which is largely used for fuel, although much of it would be valuable for commercial purposes. The tan-bark oak, although a valuable hardwood tree, has been cut in large quantities and only the bark saved. Such is the criminal waste of our resources which has been, and is still going on in this region. Madrone and laurel are scattered over the more moist slopes, and the digger pine in the drier mountains. The oaks—both white oak and live oak—give a most beautiful appearance to many of the valleys of this region.

The water power available in the Coast Ranges is small in comparison with that of the Sierra Nevadas, for the main streams flow down to the sea with a gentle grade. Owing to the fact that the Coast Ranges lie outside of

the area of glaciation, except for one or two small areas we find here but few lakes, Clear Lake being the only one of any size.

The stock raising and grain industries of earlier days have in large part given place to fruit growing, particularly in the valleys about the San Francisco Bay region, where there is good transportation to market. A most remarkable combination of climatic conditions permits the growing of a great variety of fruits, such as pears, peaches, apricots, cherries, apples, etc. In Napa and Sonoma valleys large quantities of wine grapes are grown in addition to those for table use. In the warmer valleys there are fig and olive orchards, and there is little doubt that the lemon and orange could be successfully grown.

CHAPTER XIV.

SOUTHERN CALIFORNIA.

RELIEF AND DRAINAGE.—That part of California lying south of Tehachapi is a region of great diversity of surface and climate. Although it extends through only two and one-half degrees of latitude it would be difficult to find another area of the same size which offers a wider range of life conditions and so great a variety of sub-tropical and temperate productions. Mountains whose tops are white with snow through half the year look down on the one hand on highly cultivated valleys stretching away to the sea, and on the other hand over the scorching sands of the Mohave and Colorado deserts.

Southern California is divided by a series of mountain ranges into two strongly contrasted parts. The western one slopes to the ocean, and until recently contained nearly all the population. The eastern one possesses no external drainage, and consists for the most part of barren mountains and desert valleys. This interior region is geographically a part of the Great Basin, and we shall take it up under the head of the latter region.

We shall, then, include under the designation Southern California only that portion of the State lying on the seaward slope south of Tehachapi, or more strictly speaking, south of a line drawn westerly from the extreme southern end of the San Joaquin Valley. Southern California, although very complex in detail, is, as thus defined, a geographic unit. It includes Santa Barbara, Ventura,

Los Angeles, Orange, San Diego and the western portions of San Bernardino and Riverside counties.

The mountains of Southern California are so diverse in character, and at first sight so confusedly arranged, that it is not easy to reduce them to any kind of order for the purpose of study. We can distinguish, however, two main groups or systems. One forms the northern boundary of the province, having a general east and west direction. The other lies to the south, and with its spurs has a direction nearly north and south. As we follow it south into Lower California it forms what in general terms is called the Peninsula Range.

The mountains occupying the northern portion of the Southern California province appear from the relief map to be really a continuation of the Coast Ranges which in Santa Barbara county turn more toward the east, become high and rugged, and exceedingly complex. Nearly the whole of eastern Santa Barbara county is a mass of mountains. The most important and distinct single range is the Santa Ynez, whose western end forms Point Conception, and whose position determined the abrupt change in the direction of the coast line of Santa Barbara county. To the north is San Rafael Range, Cuyama Range and the Mt. Diablo Range, all of which blend in an easterly direction in the San Emegdio Mountains. The relief map shows these mountains to be a part of the main northerly group which separates Southern California from the desert, and as we follow them easterly we pass successively the San Gabriel and San Bernardino ranges. East of the latter the chain of mountains turns again in a southerly direction, skirting the northern edge of the

Colorado Desert as far as the Colorado river. The Santa Susana and other local ranges of Ventura county, the Santa Monica Range and the Verdugo Mountains we will group with this main axis forming the northern border of Southern California.

The complex of mountains of eastern Santa Barbara and northern Ventura counties, which unite in the San Emegdio Mountains, forms one of the most sparsely settled districts of California. There is comparatively little land suited to farming, while the mountain slopes, either covered with dense brush or scattering timber, make it of little value as a grazing region. The mountains rise from 5000 to 7000 feet, culminating in Frazer Mountain, 8026 feet in height, and Pine Mountain, 8826 feet. These two peaks of the San Emegdio Mountains rise from a plateau-like base which has an elevation of 5000 feet, and contains several large valleys overgrown with sagebrush. Pine timber covers the two peaks mentioned, as well as other mountains which rise above 6000 feet.

The San Emegdio Mountains illustrate extremely well the almost inconceivable geographic changes which have taken place in this part of California in comparatively recent times. We learn from the topography that once no barriers separated the San Joaquin Valley from the Mohave Desert, and that the latter region sloped away toward the ocean, with no intervening watershed or mountains.

The drainage is away from the San Emegdio Mountains in all directions. On the north San Emegdio Cañon drains into the Great Valley. On the west is the Cuyama river, while on the south are the Piru and Sespe, tribu-

taries of the Santa Clara river. The Santa Ynez and Sisquoc rivers drain west across Santa Barbara county from the group of mountains about which we have been talking. The Santa Ynez Valley, with its tributaries, includes the larger part of the agricultural land of the county aside from the strip of land lying along the sea at the southern base of the Santa Ynez Range.

The most important stream of Ventura county is the Santa Clara river, whose direct course to the sea through a mountainous region shows that it occupies a line of folding or faulting of the earth's crust. The headwaters of the river extend away back into the mountains, almost cutting them into two parts. At one point known as Soledad Pass there is such a low gap between the Mohave Desert and this stream that the Southern Pacific Railroad easily crosses the watershed on the route from Bakersfield to Los Angeles.

Parallel mountains border the Santa Clara river nearly all the way to the sea. On the south, and separating it from San Fernando Valley, is the Santa Susana Range, and on the north, lower down in its course, Sulphur Ridge separates the river from the Ojai, a picturesque and fertile valley. The mountains upon both sides of the river throughout the middle part of its course contain valuable oil deposits.

The southern portion of Ventura county is made up in part of a rolling plateau dotted with oaks. South of this rises the Santa Monica Range which, in its east and west course, determines the direction of the adjoining coast line. These mountains rise directly from the sea throughout the western half of their course, and then

pass inland forming the northern boundary of the fertile plain of Los Angeles, and separating it from the San Fernando Valley.

San Fernando is a large valley lying north of the Santa Monica Range, and is bounded on the east and north by the San Gabriel and Santa Susana mountains. It is extremely fertile and possesses a good climate. When supplied with sufficient water, as it is likely to be when the Los Angeles aqueduct is finished, the valley will become one of the garden spots of Southern California.

From a study of the relief map one would judge that the main mountain axis of Southern California, which in its different parts is known as the San Emegdio, San Gabriel and San Bernardino mountains, is a unit as regards its history and development, just as is that great mountain block, the Sierra Nevada. Such is not the case, however, for the Cajon Pass marks an important break between the San Bernardino Mountains and the central and western portion of the axis. The two parts are of a different age and have had a very different history, and this, as we shall see later, has an important economic aspect.

As one looks southerly across the wide expanse of the Mohave Desert he sees a continuous mountain wall which forms the northern face of the axis of which we have been speaking. At the western end where the Tehachapi Range joins this, rises the lofty rounded top of Frazier Mountain. Following these mountains in an easterly direction along the southern border of the desert, we find them decreasing in height, with several low passes leading over the watershed to the Pacific slope. Among

these is Elizabeth Lake Cañon, Francisquita Pass, through which the old Los Angeles-Bakersfield stage route used to go, and to the east, Soledad Pass used by the Southern Pacific Railroad. East of the latter pass the mountains begin to rise again, and from this point to Cajon Pass are known as the Sierra Madre or San Gabriel Range. The former term was given by the early Spaniards, meaning Mother of Mountains. This is peculiarly appropriate, since recent geographic investigations have shown this range to be one of the oldest of the lofty mountains of Southern California. The bold southern front which adds so much to the scenery of Southern California, is an ancient fault escarpment which, although deeply cut by numberless cañons, is remarkably well preserved. Its origin is the same as the bold face of the San Bernardino Range and the eastern wall of the Sierra Nevada.

Each of the successive stages in the history of a mountain range has, as we have seen in the case of the Sierra Nevada, its own peculiar topographic features. The rolling uplands and plateau-like areas between the cañons in the Sierra Nevada are remnants of an ancient surface which existed before the range was uplifted and running water had an opportunity to erode the existing cañons. As time goes on and the work of water continues these cañons will be widened and the slopes of their walls reduced until no part of the old surface remains. The upland surface will have all gone and there will be left simply cañons and valleys, with their slopes terminating in sharp divides. This is the period so interestingly shown in the San Gabriel Range. It is

simply a network of steep, narrow cañons and sharp ridges. There is scarcely 100 acres of cultivatable upland in the whole range. Valleys are also absent, for the streams are not widening their cañons to any extent.

The surface of the steep mountain slopes has been so injured in past years by sheep and forest fires that in many places where there once existed a strip of bottom land we now find a barren, gravelly flood plain. This is well shown in the East Fork of the San Gabriel river. There are few springs on the upper slopes, and no true meadows occur in any part of the range. The San Gabriel Range exhibits a stage of development which makes it of the least possible economic importance. This is far from saying that the range does not play an important part in the making of Southern California. Wherever there are lofty elevations in an arid or semi-arid land there we find the precipitation increased, and so the San Gabriel Range plays an important part as a source of a needed water supply. The higher portions of the range are timbered, but the most of this is quite inaccessible, and besides is needed to protect the surface and retain the water.

The San Gabriel is a great block of the earth's crust which was once continuous with the Mohave Desert, but at some remote time was folded upward and broken along its southern face. While no level upland remains, yet the even sky-line of the ridges brings out the original character of the surface. The crest of the range has an average elevation of 6000 to 7000 feet, while the highest peak, San Antonio, or Baldy, as it is commonly called, reaches 10,080 feet.

Big Rock creek and Little Rock creek are the main streams flowing into the Mohave Desert on the north. The Santa Clara river drains the northwestern portion, and the Tejun̄ga river, source of the Los Angeles water supply, occupies the western slope. In no part of Southern California is the damage done by forest fires more apparent than in the Tejun̄ga basin. If this were reforested so that the slopes and the beds of the streams were protected from the direct rays of the sun there is no question but the water supply furnished by this stream system would be greatly increased.

Little Rock creek flows easterly, while the San Gabriel, San Dimas, and Cucamonga are the main streams flowing southerly. The San Gabriel has by far the largest water flow, and during periods of heavy rain reaches the sea. Without these streams the extensive area along the base of the range, so well adapted to fruit growing, would remain a brush-covered desert. These streams are directly due to the presence of the lofty mountains which we have been describing.

The topography of the San Bernardino Range contrasts in a most remarkable manner with that of the San Gabriel Range. The latter is old geographically, while the former is comparatively young. The Great Rift line, which we shall describe later, lies along the northern base of the San Gabriel Range, crosses its eastern end diagonally and forms the southwestern base of the San Bernardino Range. The position of this important fault and earthquake line shows clearly the likelihood of a different age and different history for the two ranges.

The San Bernardino Range exhibits rolling, flat-topped ridges, and broad valleys with numerous Sierra-like meadows. The features remind us much of portions of the Sierra Nevadas. In a broad way the surface of this range has a resemblance to the desert on the north, and there can be no doubt that it is an uplifted portion of that region.

The San Bernardino Range includes the largest area of elevated land in Southern California, and supports a boreal flora and fauna over many square miles. About the upper slopes of San Gorgonio Mountain there are numerous cold springs and green meadows. San Gorgonio, or Grayback as it is often called, is the highest peak of Southern California, reaching 11,485 feet. It lies at the eastern end of a lofty ridge, the western end of which is known as Mt. San Bernardino. The latter has an elevation of 10,630 feet, and although of no particular importance as viewed from San Gorgonio, yet as seen from the San Bernardino Valley appears fully as prominent as the main peak.

San Gorgonio is very interesting from the fact that there are clear indications of the former existence of several glaciers upon its northern slope. It thus marks one of the most southerly points of glaciation in the United States.

The two largest streams heading in the San Bernardino Range are the Mohave river and the Santa Ana river. The former flows northerly into the Mohave Desert, carrying the largest (excepting Owens river) volume of any stream entering the desert. It is but little utilized, and in the course of fifty miles sinks in the sands.

The Santa Ana is the largest and longest river of Southern California. The summer flow of this stream is unusually large, and this fact is due mainly to springs issuing from the extensive accumulation of glacial debris on the northern slope of the San Gorgonio-San Bernardino crest. These gravels hold the waters from the snow, which lasts nearly all summer in some of the protected recesses, and give it off slowly. After leaving the mountains the Santa Ana traverses a valley region of low relief, and then cuts through the northern end of the Santa Ana range, which lies in its path to the sea.

The San Gabriel and Santa Ana rivers, with their large volume of water, call forcibly to our attention the important part which mountains play in the development of Southern California. Water is so urgently needed, in order to increase the agricultural population of this section, that the greatest care and thought should be given to the protection of the watersheds about the heads of the streams. The flow from many watersheds might be much increased with the proper attention to the condition of the surface.

Two great peaks dominate this portion of California and stand guard over San Gorgonio Pass. One is San Gorgonio, and the other is San Jacinto. They belong to different ranges and are separated not only by the pass, but by the Great Rift line. San Jacinto forms the northern point of a range of the same name, and is the second highest peak in Southern California, having an elevation of 10,805 feet.

The San Jacinto Range has the appearance of being very old, and of having undergone little disturbance in

recent times. Its streams, which enter San Gorgonio Pass, carry little debris, and erosion upon its slopes appears to be slow. The very opposite appearance is presented by the streams entering the pass from the San Bernardino Range. The Great Rift which crosses the southern slope of the latter range appears to have shaken the mountains severely and badly shattered them, for immense quantities of debris are being borne down into the pass.

The San Jacinto Mountains present a wonderfully rugged and precipitous escarpment as viewed from the Colorado Desert, near Palm Spring Station. There is no doubt that this originated long ago through a slipping of the earth's crust, but if there has been any movement in late times it has been one of depression, for the base of the range appears to be buried in the accumulations of the Colorado Desert.

The western edge of the range is also marked by a fault line, but this is one along which very recent movements have taken place, as is shown by earthquakes. This latter fault line, which stands out so clearly in the mountain wall north of the town of San Jacinto, extends southeasterly into the Colorado Desert, and cuts off the San Jacinto Mountains from the rest of the Peninsula Range with which they are topographically continuous. The San Jacinto Mountains, then, extend southeasterly, finally terminating in a spur known as the Santa Rosa Range, in the heart of a barren and desolate region which forms a part of the Colorado Desert.

The mountains lying south of the San Bernardino-Los Angeles Valley, which we have before referred to as the

second most important mountain axis in Southern California, extend nearly north and south, and all seem more or less related to the Peninsula Range of Lower California. This range, although much lower than the Sierra Nevada, the highest peaks outside of San Jacinto reaching from 6000 to 7000 feet, very much resembles the latter in its general structure. There is the long western slope of San Diego county and the abrupt eastern slope toward the desert. The latter slope is marked by fault lines, so that the range is a great tilted block which has not been elevated as much as the Sierra Nevada. Plateau-like remnants of an old surface are very numerous upon the summit and western slope of the range. The Cahuilla Indian Reservation, a few miles south of the town of San Jacinto, is located upon a remarkable plateau having an elevation of 4000 feet. About the region of the mining town of Julian and the Cuyamaca Mountain, as well as on the summit of the Laguna Mountains and the Campo region near the Mexican line, are extensive plateau-like areas which formed part of an old surface before the recent moderate elevation of the Peninsula Range.

The westward sloping ridges of these mountains form a remarkably even sky-line when seen in profile, and back of the city of San Diego is a remnant of an ancient auriferous gravel channel. This old channel bears the same relation to the present cañon of the San Diego river as the old channels in Northern California do to the American and Feather rivers.

The slope from the plateau occupied by the Cahuilla Indian Reservation was once continuous westward to the ocean. The whole region had a low relief, for there were

no cañons, and only gently rolling granite hills broke the surface.

Then there came a time of slipping of the earth's crust along a line of fracture, and the Santa Ana Mountain block began to appear. A sharp escarpment formed along the eastern face of this block, and in the depression at its base we have the Temecula-Elsinore Valley of the present day. The growth of the mountain block was slow, so that Temecula creek maintained its course, and now flows from the broad valley of the same name by means of a cañon which it has cut through the mountains, to the sea. The road from Temecula to Fallbrook passes across the southern end of this uplifted block through a little valley which has been beheaded.

At Lake Elsinore the displacement was greater still, and the San Jacinto river, which at one time must have flowed westerly to the sea, formed a lake under the escarpment and was then deflected northerly, finally to empty its waters into the Santa Ana river. The climate is so dry now that rarely is there any overflow from the lake down the old course of the river.

This mountain wall, shutting in the Temecula-Elsinore Valley on the west, is one of the most striking features which we have illustrating the formation of mountains through slipping of the earth's crust. Climbing this wall from Temecula we come out upon a rolling plateau with broad valleys and low granite knobs, covered in places by the remnants of an ancient lava flow. The region is known as the Santa Rosa plateau, and one of the most symmetrical lava remnants, forming a flat-topped hill, goes by the name of Mesa Redonda.

As we follow the Santa Ana Mountains northward we find that beyond the point where the Santa Ana river crosses it the fault disappears and a fold of the earth giving rise to the Puente Hills takes its place. To the southeast we trace the fault, or slip, as we may call it, along the base of Palomar, or Smiths Mountain, bordering the valley of the upper San Luis Rey river. Smiths Mountain, then, has been raised to its present height by movements along this rift, only here the uplift was on the opposite side of the break, for the bold front of the mountain faces westerly, while farther north the escarpment faces east.

Numerous streams, the largest of which are the San Diego and San Luis Rey rivers, flow westerly to the sea across San Diego county. Their courses for the most part lie in valleys, although here and there narrowed by resistant rocks. Since their channels were first eroded the land has sunken several hundred feet, and now their lower courses are over silted-up channels. In the summer they are nearly dry, but after ordinary winter rains carry a considerable volume of water.

The Verdugo Mountains, forming a long narrow, but precipitous range, lie between the San Fernando Valley upon the southwest and a valley known as La Cañada, which separates them from the San Gabriel Range on the northeast. Most peculiar and interesting drainage features are exhibited by the streams which come down to La Cañada from the San Gabriel Mountains, for instead of going around the Verdugo Mountains, as the topography would lead one to expect, they flow directly across it. This seems to indicate that either the Verdugo Moun-

tains have been raised across the courses of pre-existing streams without displacing them, or that the San Gabriel Range has sunken. There is clearly a line of fracture and displacement running through the Cañada Valley between the two ranges.

LAKES.—Southern California, as we might suppose, has few natural lakes. Elsinore is the largest, and belongs to a type of lake frequently occurring at the foot of fault escarpment throughout the mountains of the West. At present it rarely overflows its basin, and is quite alkaline.

Lake Elizabeth, lying on the southern edge of Antelope Valley, in the Mohave Desert, is due to the blocking of a small stream which is crossed by the Great Rift. In the San Bernardino Mountains are several small lakes occupying basins which have been uplifted from the level of the Mohave Desert and have not yet been drained. On San Gorgonio are two small glacial lakes. In the head of the middle fork of the San Gabriel river is a small lake lying behind a great ridge of rock which has slid from the crest of the range as the result of some earthquake disturbance. At the mouths of some of the streams, and separated from the ocean by barrier beaches, are lagoons. These have been formed as a result of the last submergence of the coast drowning the adjacent lowlands.

One of the most interesting of the shore features found along the whole coast of California is the Mesa of San Diego county. In its main features it represents an ancient sea floor formed along the base of the mountains when the land stood lower than at present. The mesa

lies between the mountains and the sea, and terminates at the latter in cliffs. South of Oceanside lines of ancient dunes mark its surface. During a period of elevation the streams cut steep-walled valleys or cañons across it. With the last sinking of the land the sea flooded the lower portion of these valleys. Then the waves threw up barrier beaches, transforming the bays into lagoons, and since then they have been largely silted up by flood waters.

COAST AND ISLANDS.—The character and direction of the shore line at any given point is dependent upon the nature of the land lying back of it. Where mountains approach the shore the coast is rocky and bold, and headlands extend out into the sea. This is illustrated at Pt. Arguello and Pt. Fermin. Where there are lowlands lying back there are long, gently incurving sandy beaches, as are shown south of Santa Monica, for many miles both northwest and southeast of Long Beach, and at Coronado.

The present shore is a mere accident, so to speak. It is not permanent, but has moved back and forth with the rising and sinking of the land. Just how great these movements have been we do not know, but their vertical range is probably 3000 feet.

All the lowland region of Southern California was at one time the floor of the sea, and at another time the land reached far to the westward of the present boundary, including the Santa Barbara and probably other islands. We have come upon the scene while the land stands half way between these extremes, so that the surface is divided between mountains and broad lowland valleys. The fer-

tile plain upon which Santa Barbara stands is part of a much greater plain stretching away under the sea to the islands. The plain of Los Angeles is only a part of a much larger one, the remainder of which is submerged.

Between Santa Barbara and Ventura the mountains which form the great barrier between Central and Southern California come directly down to the shore, leaving room for a road only at low tide. The coast has recently risen three-fourths feet south of Los Angeles. This has given opportunity for the Santa Fe Railroad to build a number of miles of track on the sand which has accumulated at the base of the old sea cliffs south of San Juan Capistrano. San Diego is thus more easily reached than it otherwise would be. The condition of the shore is then an important economic factor in communication between different regions.

The relative position of the mountains and the character of the valleys taken in connection with the present level of the land, have given us a fairly even coast line with few good harbors. Santa Barbara roadstead is protected largely by the Channel Islands. San Pedro, originally a small shallow harbor, is being adapted to the use of large vessels by the building of a costly Government breakwater.

San Diego possesses, next to San Francisco, the best natural harbor on the coast of California. It is due to the same cause as the others, that is, the recent sinking of the land several hundred feet. San Diego Bay is protected both by Pt. Loma, a long, rocky headland, and a long barrier beach connecting with islands behind the headland.

The ocean is at most times so quiet that at many points, such as Ventura, Santa Monica, Long Beach and Ocean-side, long piers have been built for the transfer of freight and passengers.

THE ISLANDS.—All the islands except the Farallones lie off the coast of Southern California. They are tops of mountains which rise from a sunken portion of the continent to which reference has already been made. This submerged plateau widens and sinks as we follow it southward past the Santa Barbara Islands until off San Diego soundings show that its margin is fully 150 miles out beyond the present shore. In addition to the mountains on this plateau which rise above the water there are several "banks" marking the places of those which are completely submerged.

Much, and probably all, of this plateau has at some time been dry land. It is definitely known that the land has stood at least 1000 to 1500 feet above the present level, for the Santa Barbara Islands were a part of the mainland in quite recent times. On Santa Rosa Island there are bones of the mastodon, extinct horse, and other mammals. These must have reached that point by means of some land connection. There are other evidences of submergence in the shape of cañon-like depressions which extend from the land down onto or across the submerged plateau. In several instances these reach the deep sea at a depth of 2000 to 3000 feet, and are believed to have been made by running water.

That the coast of Southern California has been submerged at least 1400 feet below the present level is shown by the wave-cut terraces and ancient sea cliffs extending

up to that height upon San Clemente Island, and also upon the seaward face of San Pedro Hill. The last movement of any consequence, except the slight upward one referred to, was a sinking of perhaps 300 feet, and it is this which has given us our present harbors.

The downward movement drowned the mouths of the streams and formed bays at their mouths. The larger streams, carrying much silt, have filled these up. Many small ones still exist, in the form of lagoons, as is particularly well shown along the coast of San Diego county.

The island of Santa Catalina is important as a summer resort, Avalon being situated upon a bay formed by the last sinking of the land. The other islands are chiefly used as stock ranges. The islands, if we can judge from San Nicholas, once supported a large Indian population. The latter is now utterly barren, and is being covered with drifting sand owing to overstocking with sheep. Outside of the channel islands there is a most remarkable submerged escarpment shown by soundings. The slope is very precipitous to the depths of the Pacific, and probably represents a great fault or earthquake slip.

EARTHQUAKE LINES.—The earthquake rift of the Coast Ranges, or San Andreas fault, as it has been termed by the Earthquake Commission, which opened so disastrously in 1906, has a much greater length than was at that time supposed. It extends through the whole length of the Coast Ranges, across Southern California and into the Colorado Desert.

We have already followed it through the Coast Ranges to the Carisa Plain. From there it continues on southeasterly through the San Emegdio Mountains, the name

meaning patron saint of earthquakes, across Tejon Pass and the southern slope of Antelope Valley. Movements have occurred along this line for so long a time that valleys and cañons have had time to develop. The crushing of the rocks near the fracture line has made erosion more rapid, and hence the marked effect which it has produced upon the topography. The slipping of the walls have also resulted in important escarpments.

West of the San Emegdio Mountains San Juan Cañon has been eroded 2000 feet deep on the line of the rift. San Emegdio creek rises in an important longitudinal upland valley eroded through the heart of the San Emegdio Mountains, and this is also due to movements of the rift. Along the northern side of Cuddy Valley there is an escarpment 50 to 200 feet high which forms a straight line for some miles. The sunken side of the valley is marked by meadows.

Crossing the Tejon Pass the rift continues in an almost perfectly straight line along the southern side of Antelope Valley and the Mohave Desert. The old stage road from Bakersfield to Los Angeles follows it for some miles east of Tejon Pass. The earthquake of 1857, known as the Tejon earthquake, shook this road all to pieces, and the effects are still plainly visible.

Long narrow valleys mark the rift for many miles. It has not only affected greatly the topography of the country, but it has habitable valleys with springs in an otherwise very dry region, and has determined the position of trails and roads which follow it almost continuously.

The rift follows a straight course along the mountain slopes bounding the Mohave Desert on the south for fully

100 miles. Then, climbing the northern spurs of the San Gabriel Range, it continues over a divide 7000 feet high and descends toward the lower end of Cajon Pass. Sink holes, escarpments, springs and cienegas enable us to trace it easily almost the whole distance.

The rift traverses the mesa which lies between the base of the San Bernardino Range and the valley, and breaks it into two parts, showing in places long bluffs and ridges forty to fifty feet high. Above the rift there is an abundance of water at shallow depths; below it can scarcely be found. This is because of the impervious layer of clay in the fissure which forces toward the surface the underground waters seeping from the mountains.

Passing up Potato Cañon to the east of Riverside the rift passes over a spur of the range and then down toward the San Gorgonio Pass. It then turns more easterly along the base of the range, and after crossing the Whitewater River disappears in the sands of the Coachella Desert. The whole of that portion of the rift traversing Southern California opened in the Tejon earthquake of 1857.

Another earthquake line of importance has already been mentioned. This has produced the steep mountain wall lying north of the town of San Jacinto. This line of displacement can be traced southeasterly along the southern slope of the San Jacinto Mountains and into the Borego Desert, where it forms a wonderfully regular escarpment. A severe disturbance along this fissure in 1897 severely damaged the town of San Jacinto and killed several Indians.

The Temecula-Elsinore earthquake line appears to have ceased making any disturbance, for there are no indications of recent movements. The eastern slope of the Peninsula Range shows in many places the effects of great displacement. For hundreds of miles, extending far into Lower California, there is an abrupt wall very similar to that of the Sierra Nevada. The frequent earthquakes, hot springs and mud volcanoes of the Colorado Desert indicate that movements of the sunken desert block are still taking place.

GEOGRAPHIC HISTORY.—Something of the wonderfully checkered shore-line history of California has already been given. Fully as remarkable events have taken place in the history of the land, as we learn from a study of the existing geographic features.

The climate and geography have both been changing throughout the long periods of the past. Disturbances in the earth's crust would slowly give rise to mountains. The forces of decay, together with the rains and running streams, would attack these mountains and in the course of time wear them entirely away. Mountain-making forces do not act with the same energy in all places and at all times, while in some places the mountains wore away more rapidly than in others. It thus came about that in different regions we find mountains exhibiting different stages of development. In the Mohave Desert and about Perris, Riverside county, there are mountains almost worn down, while the San Gabriel and San Bernardino exhibit steep, rugged slopes of newer mountains. As a result of the changing land we have an ever-changing climate, fauna and flora.

A careful study of the features of Southern California leads us to believe that at one time there were no lofty barrier mountains between the Mohave and Colorado deserts and the sea. The drainage from these districts reached the sea over a surface of low relief. The San Gabriel, San Bernardino and Peninsula ranges had not been born. The summits of the sharp ridges of the San Gabriel Range, which form so even a sky line, appear to arch upward gently from the Mohave Desert with its almost worn-down mountains. The San Bernardino Range is without question an uplifted region which at one time was topographically a part of the present desert. The Peninsula Range was once much lower and exhibited no eastern escarpment, and the ancient uplifted river bed, with its gold deposits, probably had its head far to the east of the present crest and over the sunken Colorado Basin.

The geographic features of these ancient times of which we have spoken were perhaps first modified in the appearance of the San Gabriel Mountain block. A fault or slipping of the earth along its southern side began to raise an escarpment which as it grew more lofty was more and more attacked by the forces of decay and erosion until the present deep cañons came into existence, and the old upland was reduced to sharp-edged ridges. Such is the story of the still precipitous front of the San Gabriel Range, which adds so much to the scenic features of this region.

At a much later period movements along the Great Rift, of which we have spoken, began to uplift the San Bernardino Mountain block, but the ancient surface of

this area has not yet been greatly modified, although cañons have been eroded about its margins, and these will in time reduce it to the same condition as the San Gabriel. Both ranges will, at some time in the distant future, if other movements do not interfere, take on much of the appearance of the rolling, hilly country about Riverside and Perris.

The old features of the last-mentioned district are relics of the most ancient geography which we can distinguish in California. The time required for lofty mountains to be worn down to a surface almost plain-like in character, such as that southwest of Perris, is greater than we can conceive of. It is this contrast between very ancient and comparatively new geographic forms which we find so well shown in the area which we have been discussing that makes its study so interesting. Here we also see in remarkable distinctness the dependence of the climate and productions, as well as man's industries, upon the physical features of the earth.

GEOGRAPHIC BARRIERS.—With all the modern conveniences for travel we are apt to forget the difficulties which the early explorers encountered in trying to get into California. One expedition ascended the Colorado river, but did not get far away from it because of the inhospitable character of the country. A long and weary route led overland from the Missions of Lower California to San Diego, and the sea with all of its head winds offered the only other means of access.

Except for the one route up the coast, where the mountains crowd the road to the edge of the sea, mountain ranges and deserts completely shut off Southern

from Central and Northern California. When the interior became better known another route by Elizabeth Lake, Tejon Pass and cañon came into use, but much of the way was desert, and there were three mountain passes to cross, namely, San Fernando, Francisquita, and Tejon. The main route, however, continued to be that along the coast known as the Camino Real. The latter lay mostly through well-watered valleys, and with only two passes of any consequence, Gaviota across the western end of the Santa Ynez Range, and Cuesta Pass leading from San Luis Obispo across the Santa Lucia Range.

The deserts offered more effective barriers to the early emigrants from the East than did the mountains. It was practically impossible to cross the Colorado and Mohave deserts in the heat of summer, but there were several passes leading through the mountains into Southern California which could be used at all seasons.

Mountain passes have had an important influence upon the development of Southern California. This fact is illustrated in the relatively rapid growth of Los Angeles as compared with San Diego. The former is situated directly at the meeting point of valleys which lead to mountain passes opening east and north, while San Diego, having the great advantage of being located upon the second best harbor upon the coast of California, is nevertheless, so hemmed in by mountains that it has been difficult for railroads to reach it. Even the route along the coast, occupied by the Santa Fe, was not an easy one to follow. The Peninsula Range offers no low passes,

but it is now proposed to build a railroad across it, and thus go direct from San Diego to Yuma.

San Gorgonio is the easiest and lowest pass leading into Southern California. It has an elevation of only 2600 feet, and is really a broad valley connecting San Bernardino Valley with the Colorado Desert, which has been arched upward in the middle during mountain-making movements. It is used by the Southern Pacific Railroad.

Cajon Pass is higher and steeper than San Gorgonio Pass. It lies in the break between the San Bernardino Range and the San Gabriel, and opens out on the north into the Mohave Desert. The pass is used by both the Santa Fe and Salt Lake railroads. In early days it was made use of by the Mormon trail, which led from Utah across Southern Nevada to the San Bernardino Valley, where these people had made a settlement.

The Southern Pacific Railroad in going from the San Joaquin Valley to Southern California crosses three mountain passes, namely, Tehachapi, leading to the Mohave Desert; Soledad, between the desert and the head of the Santa Clara River, and San Fernando, between the latter basin and the San Fernando Valley.

The emigration into California by the southern routes was comparatively small in the early days. This was partly because the deserts of the Southwest were more dangerous to cross, and partly because the mines were reached more directly by the northern route. Two trails were used to reach Southern California, one across New Mexico and Arizona, entering California at Yuma. The other, known as the Old Mormon trail, has already been mentioned. From Yuma one route led to San Diego,

the other to Los Angeles. Winter parties sometimes made use of these routes, and it was in the effort to find a new cut-off to the north of the Mormon trail that the Death Valley party had its terrible experience.

CLIMATE.—The climate of Southern California has already been discussed in a general way. Although lying in the belt of prevailing westerly winds, fewer storms reach this southern coast, and the climate is drier than farther north. The precipitation varies greatly in different parts. It averages 10 inches at San Diego. At Los Angeles it is about 15, while upon the mountains it is from 40 to 50 inches. We would ordinarily expect the greatest rainfall to occur along the coast, but owing to the cooler air of the mountains, and the disturbance which they create in the atmospheric currents the precipitation upon their slopes is very much greater. The influence of the mountains is, then, a very beneficent one, for if it were not for them the rainfall would be so small that there would be no streams of any consequence, there would be no snow and no summer supply for irrigation.

The lack of rainfall from storms accompanying the easterly moving air currents is partly compensated for by the existence of a summer storm area over the Gulf of Lower California. Storms from this center sometimes reach into Southern and Eastern California, producing thunderstorms and cloudbursts in the late spring and summer which may be very severe. In the summer of 1909 as much rain fell in a single storm in the Colorado Desert as ordinarily fell in a whole year.

While the summer fogs are much colder and more dense along the coast, yet owing to the fact that there

are no intervening mountain ranges their influence is felt far inland. "High fog" occurs very frequently in the mornings in summer, even in the San Bernardino Valley. Thus it happens that many fruits, including oranges, ripen later in Southern California than in the Great Valley, hundreds of miles farther north.

A disagreeable wind from the north occurs in the spring and fall, and often does considerable damage. This is known as the Santa Ana, and while it lasts the sky is obscured by clouds of dust. It is a high-pressure or anti-cyclone wind due to the existence of such an area over Southern Nevada. Its warm dry character is not wholly due to its passage over the deserts, as is commonly supposed, but more to the fact that it is a descending air current, and such currents are drier and often warmer than other winds.

NATURAL RESOURCES.—California is made up of so many and diverse parts that we can describe its resources most intelligibly by taking each part by itself. Southern California is noted particularly for its oranges, and undoubtedly the growing of citrus fruits will always be the leading occupation. The dividing up of the land into small tracts, each of which is cultivated with care, will keep the larger part of the population in the country and small towns, and lead to the best type of our modern civilization.

Owing to the fact that the area that is sufficiently high to receive heavy rains is comparatively limited, the timber resources of Southern California are not extensive. Important lumbering operations have been carried on in the San Bernardino Range for some years, but careful

measurements of the streams which flow from the deforested areas indicate clearly that the effect upon the summer supply will be disastrous if this work is not soon stopped. It is far more important that Southern California be not stripped of her forest cover, and thus cripple the water supply which goes to support thousands of people, than that a few lumber companies should grow rich.

The coniferous forest is practically confined to the mountain slopes above 5000 feet, although there is one species, the big-coned spruce, which can thrive upon drier slopes, and grows much lower. Below the coniferous forests, particularly where the slopes are steep, the surface is covered with a dense growth of chaparral, consisting of scrub oak, California lilac, chamisal, manzanita, etc. The more moist valleys are dotted with oaks, as are the valleys of the Coast Ranges. Many of the more arid valleys and slopes support a growth of sagebrush and other semi-arid shrubs.

If we except petroleum, the mineral resources of Southern California are comparatively limited. Gold occurs from the San Emegdio Mountains southward in those parts of the mountains made up of the ancient crystalline rocks. Antimony was formerly mined in the San Emegdio Mountains, and a tin mine was at one time in operation in the mountains east of South Riverside. At Colton there are important marble deposits used in making lime.

In San Diego and Riverside counties occur valuable deposits of tourmaline, beryl and kunzite, which are next to diamonds, perhaps the most valuable of gems.

It is interesting to note, in connection with a description of the minerals of Southern California, that here was made the first discovery of gold. In San Francisquita Cañon, fifty miles northwest of Los Angeles, gold was discovered in placers in the year 1838, and these were worked with profit for some years. The priests, however, discouraged mining by the Indians, fearing it would take them from the missions. In 1843 a Mexican officer attempted to arouse his government to the possible importance of gold in California.

Deposits of petroleum occur over a wide area in Santa Barbara, Ventura, and Los Angeles counties. The oil is usually obtained by drilling, but in portions of the Ventura field it is obtained from tunnels run into the sides of a mountain. In the field southwest of Los Angeles is the deepest well ever drilled. It extends more than a mile down into the earth.

A most interesting and remarkable collection of fossils has been obtained from the La Brea tar springs, a few miles southwest of Los Angeles. Here is an almost complete representation of the animals which inhabited this region during the last few thousand years. Some came to drink the water and fell into the tar; others, such as the carnivorous animals, got in while attempting to feed upon other animals which had been caught. Nearly all the animals and birds whose skeletons have been found are now extinct.

WATER SUPPLY.—In no other part of California is the question of an adequate water supply so important as in the region which we are discussing. Here are many hundreds of thousands of acres of land suited to the

growth of a great variety of sub-tropical fruits, but without water for irrigation little of this great region could support more than a sparse population.

We have already seen that it is due to the presence of lofty mountains lying back of the lowlands that there is any water for irrigation. The water now used is obtained partly from the gravels along the base of the mountains, by means of wells and pumping plants, partly from the natural flow of the streams, and partly from artificial reservoirs constructed in the mountains. Bear Valley reservoir, in the San Bernardino Range, is the most important of the latter sources.

The limit of the agricultural possibilities of Southern California with the water now at hand has nearly been reached. There are various ways by which the supply can be enlarged. Los Angeles and the region about will soon have a greatly augmented water supply in the great Owens river canal. Large quantities of water run away to the sea during the winter floods, and this should all be conserved for summer use through the construction of reservoirs.

Another factor which will affect the water supply, but which has not yet attracted the attention which it should, is an increase in the forest area. Incalculable damage has been done the slopes about the headwaters of many of the streams by forest fires. In the basin of the upper Tejuanga river, from which Los Angeles gets its present water supply, there are many square miles of country once forested which are now almost bare. The stream bed is open to the hot sun, and a large part of the water which would otherwise reach the valley is now evapor-

ated. The indiscriminate cutting of the lumber of the mountain slopes of Southern California must be stopped, for every acre cut over lessens the supply by a certain amount.

VALUE OF DIFFERENT SLOPES.—We can, from an economic standpoint, distinguish three different types of surface and soil in Southern California. First, there is the mountain upland with slopes of varying steepness where the bedrock is undergoing disintegration and running water is removing the loosened rock particles with greater or less rapidity. Where the accumulation of rock particles is faster than the removal we find a layer of soil of slowly increasing thickness. Where erosion is more rapid we have crags and steep rocky slopes.

The waste rock material, including fragments of all sizes from sand and clay up to those several feet in diameter, are swept into and down the deep narrow cañons by the rains which are frequently torrential in character. At the mouths of the cañons, the water no longer confined, spreads out and loses its transporting power in a large degree. The coarser material is dropped, and only the finer is borne on to the lowlands and finally to the sea. Gravel slopes at the bases of the mountains characterize the whole of the Southern California region. They are formed of the coalesced debris fans and are most strikingly shown along the southern base of the San Gabriel Range. They contain vast stores of water, and have generally a rich soil. The good drainage, and climatic conditions particularly, adapt them to the growing of oranges.

The gravel slopes along the base of the San Bernardino Range are considerably eroded by the present streams, owing probably to a recent uplift of these mountains. The dissected and truncated remnant is known as the "Mesa." This forms the very best orange land, and is more nearly free from frost.

Below the slopes which we have been describing are the bottom lands and flood plains of the streams. These are particularly adapted to the growing of vegetables, alfalfa, walnuts, sugar beets, etc. In addition to the types of land described there are considerable areas of gently rolling lands whose materials accumulated beneath the sea when the country stood lower than now. These soils are always fine and rich. Near the sea there are damp marshy areas of similar origin, rich in peaty organic matter, and are particularly adapted to the growing of celery.

INDUSTRIAL DEVELOPMENT.—The industrial development of Southern California can be divided into three somewhat overlapping stages, namely, pastoral or grazing, general agriculture and grain raising and horticulture; or fruit growing. The first belongs characteristically to the old California days when life was taken easily and only work enough done to make a living. Hides and tallow were the only products for which there was much of a market. They were taken by the American trading vessels which frequented the coast during the earlier half of the last century.

From the very first settlement of the State irrigation was considered necessary for the successful growing of garden products and orchards, but only sufficient was

raised to satisfy the needs of the various small communities. The grassy hills and brush-covered valleys were considered valuable only for the grazing of horses, cattle and sheep. With the increase of the population it was discovered that large areas of what was supposed to be almost worthless lands would produce good crops of wheat and barley in years of average rainfall. California came to be known as a great grain State, and shipment was made by boats to all parts of the world.

Orange trees were introduced into California by the Mission fathers, and small orchards were maintained at the various settlements, but with the secularization of the Missions these were generally neglected. It was not until the coming of the railroads into Southern California that the growing of fruit was undertaken on a large scale, for previous to this event there was no way of shipping it outside the State. Beginning about the time of 1870 there has been a continual growth of the fruit industry, along with the continually increased shipping facilities and a more extensive application of irrigation. Perishable fruits and vegetables can now be distributed all over the United States and portions of adjoining countries. We see, then, that water for irrigation and a means of getting the products to market were the two geographic factors, in addition to a favorable climate and miles upon miles of fertile soil, which were needed in order to turn brush-covered wastes into smiling gardens which would support a great and prosperous agricultural community. The development of a larger summer water supply is the one thing needed now more than

all else that the thousands of acres of still unoccupied land may be made to produce.

The climate and generally picturesque surroundings of the valleys of Southern California will always make it an attractive region. Los Angeles has become almost as large as San Francisco, and in addition to being a tourist center, is assuming importance in commercial and manufacturing lines. The annexation of San Pedro gives Los Angeles a seaport which will be of great importance when the harbor improvements are completed. It is probable, however, that Los Angeles will continue to be noted chiefly for those things with which nature has endowed it, namely, an agreeable climate and far-reaching fertile valleys backed by rugged mountains.

San Diego is the second city in size in Southern California, and because of its magnificent harbor, will become of great commercial importance. It is also noted as a summer and winter resort, for it has a remarkably equable climate. In the valleys lying back from the coast oranges, lemons, and grapes are grown, while higher in the mountains there is an important apple region.

Santa Barbara is noted as a resort, as well as for its groves of olives and walnuts. The town is situated on a fertile plain at the base of the Santa Ynez Range. With these mountains on the north and the Channel Islands lying out at sea, the region is well protected from harsh winds.

Pasadena, having an elevation of nearly 1000 feet on the gently sloping plain at the foot of the rugged San Gabriel Range, has an ideal location for climate and beauty, and has become far-renowned as a winter resort.

San Bernardino, Redlands, and Riverside are equally noted for their pleasant winter climate, and are surrounded by orange orchards.

Long Beach, Santa Monica, and Redondo have become important places, chiefly because of their attractive beaches. Avalon is the most widely known of the island resorts.

CHAPTER XV.

KLAMATH MOUNTAIN REGION.

LOCATION AND BOUNDARIES.—The term Klamath Mountains is applied to a lofty, mountainous area in the northwestern part of the State. Although on geographic grounds this region is not easily separated from the Coast Ranges and Cascades, yet, when we come to study the rocks and the history of the region we see that the distinction is a good one. The Klamath Mountains resemble the Sierra Nevadas in their surface features, in their ancient rocks and in their mineral deposits.

The older text-books state that the Coast Ranges, Sierra Nevadas, and Cascade Range meet in Mt. Shasta, but this classification is no longer accepted. The Sierra Nevadas really terminate in Plumas county, and the mountains which continue on toward Shasta are a part of the Cascade Range. Throughout Oregon the Cascade Range is formed entirely of volcanic materials, and these extend south past Shasta and Lassen to the ancient rocks of the Sierra Nevadas, which disappear in northern Plumas county. These volcanic mountains and plateaus of Northeastern California fill what was once a great depression extending northeasterly from the upper Sacramento Valley. This depression separated the Sierra region from the Klamath Mountains, and reached into Southern and Eastern Oregon. According to this distinction, Mt. Shasta is one of the great peaks of the Cascade Range, and is separated from the Klamath Mountains by Shasta and Strawberry valleys.

North of Redding the Klamath Mountains send a long spur eastward, and include most of the rough mountainous district between the upper McCloud and the lower Pitt river. This spur is surrounded on three sides by the lavas of the Cascade Range.

PHYSICAL FEATURES.—The Klamath Mountains, like the Sierra Nevadas, San Gabriel and San Bernardino ranges, were once much lower than they are now, and their surface features were quite tame and uninteresting. The rivers of that time flowed through broad valleys, portions of which still remain as plateau-like shoulders overlooking the deep cañons of the present day.

There came a time when the region began to rise, and with the increase of slope the streams began to deepen their channels. As one looks at a relief map he is puzzled to understand why the Klamath river leaves the broad Shasta Valley and flows through the mountains in a deep cañon direct to the sea. If we should fill up the cañon the Klamath river would first form a lake in Shasta Valley and then break through the lowest point in the rim which leads in a southerly direction past Mt. Shasta to the Sacramento river.

The only way in which we can explain the peculiar features mentioned is by the supposition that long ago, before the mountains had been elevated to their present height, the lowest outlet to the sea lay directly across the mountains where the river flows now, and that as they rose the movement was so slow that the river was able to cut its channel down, and so maintain its position, until the cañons became 2000 to 3000 feet deep.

Only three valleys of any size are found within the whole Klamath Mountain region. The most important one is Scotts Valley, then comes Hay Fork Valley and, last, Trinity Valley. In addition, the cañons widen here and there sufficiently to give room for a little bottom land, and if the soil has not been washed away in hydraulic mining, we are likely to find little ranches. The rest of the surface is mostly made up of steep and rugged mountain slopes terminating in deep cañons.

The Klamath Mountain group includes a number of distinct mountain ranges which form the watersheds of the different river basins. The highest and most picturesque of these is the Salmon Mountains, which constitute the divide between the Salmon and Trinity rivers. Several peaks have an elevation of over 9000 feet. This region, in common with the other higher mountain ridges of the Klamath Mountains, was once glaciated. There are, in consequence, numerous little alpine lakes very similar to those in the Sierra Nevadas. The snow-fall is heavy, and on the north slope of Thompsons Peak, which rises 9345 feet, there is a small glacier.

Scotts Mountains lies between the head of the North Fork of Trinity river and the upper Sacramento. They include Castle Crag, widely known for their striking scenic features.

The Siskiyou Mountains lie north of the Klamath river and partly in Oregon. They include several peaks about 9000 feet in height. The Trinity Mountains form a high, sharp divide between the Trinity river and the Sacramento river. They pass southward into the Yalho

Bally Mountains, which lie at the extreme southern end of what we are calling the Klamath Mountains.

The Trinity is the largest stream which lies wholly within the Klamath Mountain region. Its various branches drain the southern portion, and its waters finally reach the Klamath river.

The Klamath is the largest river of Northern California. It rises in the lake region of Southern Oregon, and flows a little south of west across a depression in the Cascade Range, or rather volcanic plateau, as we shall call this part of it in the following pages, and directly into and through the Klamath Mountains, as we have already seen.

The Sacramento river also cuts across the Klamath Mountain region. Its main source is in large springs near the southwest base of Shasta, and flows southerly through a picturesque cañon. Long ago a lava stream swept fifty miles down this cañon, burying the old river bed. The present stream has cut down through the lava and exposed in some places the gravels of its former channel.

The McCloud river lies east of the Sacramento, and flows nearly parallel with it. Its waters issue in great springs from the side of the cañon, and give a constant flow of pure cold water throughout the year. These springs, like other large springs in Northeastern California, are due to the fact that the surface waters sink down through the lava and collect in underground streams. The lower McCloud river is bordered by picturesque limestone mountains, in the caverns of which extinct animal remains have been discovered.

One of the most interesting mountain trails in California is that which leads from Scotts Valley westerly along the divide between the Klamath and Salmon rivers. The scenery is attractive, and in addition we can see from many points the even sky-line ridges of the ancient Klamath country which existed here before the present mountains and cañons. For many miles these even-topped ridges approach 6000 feet in elevation, while at their upper limits rise the peaks which long ago were comparatively insignificant in height, but which now reach 8000 to 9000 feet.

The mountains were lifted to their present position by stages, and at each period of rest the streams, after having established a new grade and ceased to cut down, began to meander on their flood plains and widen their channels from cañons to valleys. Then, when the uplift was renewed they began to cut down again. In this way were formed the river terraces, some of which are covered with gravel and are rich in gold.

CLIMATIC FEATURES.—The climate of the Klamath Mountain region varies greatly in different parts. Upon the coast it is extremely wet, and the temperature is mild, but as we go inland the precipitation becomes less, the summers warmer and the winters colder. On the higher mountains semi-arctic conditions prevail. Upon the eastern edge of the district the rainfall is comparatively light.

Here, as in many other parts of the State, there is a remarkable vertical range exhibited by many plants and trees. The madrone ranges through 3000 feet, under the right conditions of slope exposure. On the dry, sunny

slopes of some of the cañons occur such plants as the Spanish bayonet, which normally belong in the semi-arid portions of the State.

RESOURCES.—The Klamath Mountains early became known as a mining region, chiefly on account of the placers, which proved to be very rich. Gold was found both in the gravels of the present streams and in the terrace remains of the older streams. The gravels were often so deep that they could not be worked by ordinary placer methods, and so recourse was had to hydraulic operations. The "bars," as they are often called, are now largely worked out, but at one time hundreds of "giants" were hurling streams of water with terrific force at the gravel banks and washing their materials into long sluices where was placed quicksilver to catch the gold as it was swept along.

West and northwest of Redding are many old mining camps, some of which are thriving today on quartz mining, while all through the Klamath Mountains are veins bearing gold and copper.

The agricultural population of the Klamath Mountain district is mostly confined to the three large valleys which have been mentioned, and to valleys about the borders. In Scotts Valley dairying and cattle raising are important industries, while fruits of the temperate latitudes do well in all the valleys.

Forests are among the most important resources of the Klamath region. Owing to the inaccessibility of the greater part of these forests lumbering has been mostly confined to the coastal region and to the district about the head of the Sacramento river. The redwood tree

reaches its northern limit in Del Norte county. The other important lumber trees are the yellow pine, sugar pine, spruce and fir.

The effects of careless lumbering are seen in the devastated region about Sissons and in the McCloud River Valley. Here is a beautiful and attractive region lying at the base of that scenic wonder of California, Mt. Shasta, which has been practically ruined in having its forests stripped off. There is no more attractive summer outing region in the State, and the main body of the forests should have been left. Many valuable mineral springs are scattered along the upper Sacramento river cañon, and large numbers of people resort to them.

CHAPTER XVI.

THE VOLCANIC PLATEAU REGION.

While there have been volcanoes and lava flows in nearly all parts of California at various times in its geographic history, yet it is in the northeastern portion that we find them most extensive. One of the greatest lava floods of the earth's surface covers Eastern Oregon, Eastern Washington, Southern Idaho, Northern Nevada and Northeastern California. Throughout a long period of time this region has been subject to the outpouring of molten material from within the earth. This was partly in the form of lava streams which spread in thin sheets over the country, and partly solid or semi-solid material which was blown out of the craters of innumerable volcanoes and cinder cones. The then existing geographic features were buried by the lava, sometimes to a depth of 2000 to 3000 feet. Here and there islands of the older surface rose above the flood, while about the borders its relation to this old surface was that of the sea to the land, with bays of lava instead of water. In this manner was built up what we call the Columbia Plateau, which is today one of the most prominent topographic features of the Northwest.

Folding and slipping of the earth's crust along lines of fracture followed the building of the plateau, so that now it appears broken up by many mountain ranges. The most important of such ranges in California is the Warner Range in the extreme northeastern corner. This both creates a water supply for the fertile Surprise Val-

ley, and cuts it off from the coast drainage and throws it into the Great Basin.

An examination of the relief map shows Northeastern California to be a plateau elevated 3000 to 5000 feet, with many broad, plain-like valleys and low mountain ridges. Here are lava flows, some very ancient, and others so recent that soil has not yet accumulated on their surfaces. Here are also innumerable cinder cones, and one line of lofty volcanoes beginning with Lassen Peak on the south and reaching north past Mt. Shasta. This line of peaks, with the high land from which they rise, is known as the Lassen Peak Volcanic Ridge and, as already explained, belongs in the Cascade Range.

The lava streams frequently interrupted the drainage upon the volcanic plateau, giving rise to lakes. At the present time most of the lakes have been drained by the streams cutting down their channels at the outlets. Large lakes once existed in Fall River and Big valleys.

The main stream draining the plateau region is Pitt river. It had its source in former times in Goose Lake, a large body of water upon the California-Oregon boundary, but with the small rainfall of the present time the lake does not overflow.

Tule Lake is another large body of water upon the northern boundary of the State. Long ago it emptied into the Klamath river, but now the evaporation is equal to the inflow, and the water has become quite alkaline. The Klamath reclamation project will partly drain this lake.

Large areas of country have no surface drainage, owing to the porous character of the underlying lava.

The water seeps downward until it encounters a layer of gravel between two lava flows, where it continues in the form of underground streams. Reaching the edge of the overlying flow or the side of a cañon, it comes out as large cold springs. Such springs are common along the base of the Cascade Range, both in Oregon and California. They are often so large that they form full-fledged rivers. Fall river, a clear, cold stream in eastern Shasta county, is formed entirely of such springs. One of these, alone, has been used to run a sawmill. Another group of similar springs give rise to Hat creek, a tributary of Pill river.

Eagle Lake lies near the southeastern border of the Plateau region, and from the fact that it has no outlet, might be considered as lying in the Great Basin. It is, however, surrounded by a volcanic country.

VOLCANOES AND RECENT ERUPTIONS.—With the exception of a small area near Mono Lake there is no other part of California presenting such interesting volcanic phenomena. At Cinder Cone, a few miles northeast of Lassen Peak, occurred what was probably the last eruption in the United States. The stubs of some of the trees killed by the ashes thrown out of Cinder Cone are still standing. Later even than the cinder eruption which built this cone there was a flow of black basalt which spread over about ten square miles of country. The lava was viscous and cooled with a very rough surface and very precipitous margins, sometimes fully seventy-five feet high. The lava formed a dam across a valley and gave rise to Snag Lake. The eruption probably occurred less than one hundred years ago. The

recent date of the eruptions at Cinder Cone brings forcibly before us the possibility of such events in the future.

West of Tule Lake are the Modoc Lava Beds, which are interesting from the fact that the lava is full of caverns which were occupied by the Indians during the Modoc war, the last outbreak in the State.

Hot and boiling springs are found in the neighborhood of Hot Spring Valley, a few miles southeast of Lassen Peak. There is one group of boiling mud springs known as the Devil's Kitchen. A body of water, underlaid by boiling springs, is called Lake Tartarus.

Lassen Peak has an elevation of 10,437 feet, and has been greatly eroded by stream and glacial action. Mt. Shasta, rising 14,380 feet, is the most striking mountain in California. This is due to the fact that it rises from a base which is comparatively low, about 4000 feet. The fringe of forest on the lower slopes and the snow-covered top standing all alone, offers a grand and majestic spectacle. Erosion is rapid in the soft fragmental materials of which it is largely composed, and in time will reduce it to comparative insignificance. Many older and almost worn down volcanoes are scattered along the crest of the Cascade Range. A number of glaciers of considerable extent are found upon the northerly slopes, and are doing their share in tearing down the mountain.

We must bear in mind, in studying the geographic features of volcanic regions, that lava flows generally produce gentle slopes and spread over the surface in thin sheets, while the cinder cones and lofty peaks, such as Shasta and Lassen, with their steep slopes, are formed

in large part of the solid or semi-solid fragments of lava hurled from the craters during the periods of violent eruption. These fall down about the orifice and thus gradually build up the rim of the crater. Lava flows may burst from the crater, but they are more likely to break out part way down the outer slope, or near the base.

CLIMATE.—Owing to its elevation the winter climate is colder than that of most of the other settled portions of California. The precipitation decreases as we go from the main Lassen Peak volcanic ridge easterly, so that fully half of the region has a semi-arid climate. There is generally sufficient rain to produce grain, but gardens must be irrigated.

RESOURCES.—There is but little mining in the plateau region, for the older rocks which in other parts of the State carry minerals are here buried by the lava. The important industries are lumbering, agriculture, and stock raising. The population is scattered, and there are no towns of any size in the district.

The western part of the plateau region lies within the great forest belt of the Sierra Nevada-Cascade Range. As we go eastward toward Nevada the lessened rainfall is shown in the fact that the forests become confined to the mountain ridges, while the valleys are covered with sagebrush.

Much of the region about Mt. Shasta has been lumbered over, and owing to careless and destructive methods will be non-productive for a long time. In other parts the forests are now being cut, but it is to be hoped

that before the country is entirely stripped that enlightened methods will be introduced.

The large valleys of the central portion of the region are given over to a variety of farm products, but the region is so isolated that few of these can be shipped to market. Grain and hay are produced for stock, and as the latter can be driven out they form the most important product.

Fruit, particularly apples, are now grown in many of the valleys, and with the entrance of railroads into the region will prove profitable crops.

The plateau province embraces Lassen, Modoc and the eastern part of Shasta and Siskiyou counties.

CHAPTER XVII.

THE GREAT BASIN PROVINCE.

EXTENT AND GENERAL CHARACTER.—Fremont was the first to explore and describe that vast interior portion of the continent lying between the Rocky Mountains and the Sierra Nevadas. He found it to be a succession of sandy deserts and barren mountain ranges with no external drainage. Here and there were alkaline or saline lakes, often disappearing completely during the heat of summer and leaving a white crust over the surface. There were almost no streams, save torrential ones, which existed for a short time after exceptionally heavy storms, and springs were few and hidden away in the mountain recesses. The larger part of the torrential waters were either evaporated or absorbed in the sands, so that the different basins, of which there were hundreds and perhaps thousands, never overflowed, and no drainage system was set up. Fremont pictures this vast desert region, or Great Basin, as he called it, as dreary and desolate, and what little life it contained as dwarfed and peculiar in character. For us, who can now enter this region under more favorable circumstances, it has most wonderful attractions. The desert, at certain seasons of the year when the air is cool and the sky clear, is one of the most inspiring regions of the continent.

We must not conceive of the Great Basin as a simple region with a rim of inclosing mountains, but rather as made up of an almost innumerable number of smaller basins. The bottoms of some of the basins or valleys

have an elevation of 6000 feet, while others are below the level of the sea. The Great Basin includes the western part of Utah, nearly the whole of Nevada, and the eastern one-third of California.

In spite of the geographical importance of the Great Basin, it is hardly more than mentioned in our geographies, and most school children know nothing about it. The region forms one of the most important barriers separating California from the East, contains valuable deposits of the precious minerals, and owing to its unique climatic conditions, contains some of the most important beds of salt, soda and borax known in the world.

The northern and southern boundaries of the Great Basin are determined by the drainage systems of the Columbia and Colorado rivers, respectively. Its western boundary, beginning in Northeastern California and going south, is first; the Warner Range, followed by the Sierra Nevada, Tehachapi, San Emegdio, Francisquito, San Gabriel, San Bernardino, San Jacinto and Peninsula ranges. The watershed separating the Pacific drainage from the Great Basin forms the meeting point of two sharply contrasted climatic provinces. In the desert one, which we are discussing, are many strange plant and animal forms. At first sight these seem few in number and to have a hard struggle for existence, but in reality they are very numerous and have become so adapted to their conditions that life for them is as easy as it is for organisms in other regions.

SURFACE FEATURES.—That part of the Great Basin lying in California is far from having a uniform character. For convenience we might distinguish three parts,

namely: (1) The narrow strip lying east of the Warner Range and Sierra Nevadas; (2) the Mohave Desert, occupying a large area in the central southern part, and (3) the Salton Sink, otherwise known as the Colorado Desert or Imperial Valley.

In the extreme northeastern corner of the State the lofty Warner Range, with its eastern fault escarpment, supplies water for the fertile Surprise Valley. This is perhaps the best cultivated portion of the Great Basin in California. In the center of the valley is a sink containing three alkali lakes which nearly dry up in the middle of summer.

Farther south we come to Honey Lake and valley of the same name. This valley lies close under the fault escarpment of the Sierra Nevadas which, although not as high as farther south, is yet quite precipitous. The part of the valley lying along the base of the mountains is dotted with many ranches, water for irrigation being supplied by streams from the Sierras. Susanville is the leading town of this region. The next important feature to the south is the Lake Tahoe basin. This lake, although lying high up in the Sierras, in a region of heavy precipitation, drains through the Truckee river into the Great Basin. This is the largest stream of the whole desert region. Much of the water is now diverted to irrigate thousands of acres of sagebrush desert in Nevada, and what is left finally reaches Pyramid Lake, in the north-western part of the State.

The next important basin to the south is that occupied by Mono Lake. This body of water and the surrounding volcanic region offers one of the most interesting places

for study in the whole of California. The lake itself lies in the lowest portion of a sunken fault block, back of which rises the snow-covered peaks of the Sierra Nevada. This region is still sinking, as is evidenced by the fact of an escarpment at the point where Mill creek issues from the mountains, which shows a recent displacement of forty feet.

Mono Lake has about the same elevation as Lake Tahoe, but instead of being pure fresh water, is so intensely alkaline and saline that the only form of life which it contains is a brine shrimp. The islands in the lake are formed largely of lava, and one contains a volcanic cone. The fissured and broken rocks tell the story of violent earthquakes following the cessation of the volcanic activities.

South of the lake is a group of mountains known as the Mono Craters, which are extremely interesting. At one spot is a flow of black lava which looks as if it had cooled but yesterday. At other points are deep craters formed by explosive forces, while fine pumice or "volcanic ashes," is spread all over the surrounding country. In one crater is an eruption of obsidian lava or volcanic glass, as it is often called. Here the Indians used to come for the material for their arrow and spear points, and this, through exchange, was taken to distant parts of the State.

Continuing south along the eastern base of the Sierras over a volcanic country which in places has the appearance of a table land, we reach Owens Valley. This is the largest, with the exception of Imperial, of the valleys of the Great Basin which lie in California, and supports

a considerable population. The valley occupies what we might call a deep trough, although it has an elevation of 4000 to 5000 feet, between the rugged Sierras on the one hand and the Inyo-White Mountain Range on the other. The highest peak of the White Mountains has an elevation of over 14,000 feet, while on the opposite side of the trough rises the lofty escarpment of the Sierras, with peaks culminating in Mt. Whitney, 14,501 feet. The length of Owens Valley is about seventy miles, and average width ten miles. It is due to the dropping of the earth between the two mountain ranges, and is in reality formed of two main blocks, the eastern one of which is occupied by the lowlands along Owens river, while the western one is higher, and is best exemplified in the Alabama Hills, near the town of Lone Pine. The great Owens Valley earthquake of 1872 was the result of movement between these two earth blocks.

East of the Inyo-White Mountain Range we find a succession of desert valleys and north and south mountain ranges taking us into Nevada. Saline Valley, at the eastern base of the Inyo Range, is of great interest. The block of the earth's crust which forms the valley has been dropped in times so recent that the mountain wall, which rises above it fully 8000 feet, is still extremely precipitous.

Owens Lake is a large shallow body of water, and very alkaline. Although it receives the drainage of the eastern slope of the highest parts of the Sierras, yet it is steadily decreasing in size, and will eventually disappear. This event will be hastened through the construction of the Los Angeles aqueduct, which will take away a large por-

tion of the water of Owens river. Mono Lake, on the contrary, is rising slowly. Its waters can never be diverted, owing to the nature of the country, although some of the supplying streams can be used for irrigation.

Owens Lake overflowed its basin during the glacial period and sent a mighty stream southward between the Coso Mountains and the Sierra Nevada. The gap is known as Little Lake, from a body of water occupying a portion of the ancient channel. The stream spread over a part of the Salt Wells Desert, and finally reached the basin known as Searles Borax Marsh. The shore lines of the ancient lake are still clearly marked along the sides of the inclosing mountains.

The Argus Range, the Panamint Range and the Funeral Mountains lie east of the Sierras and north of the Mohave Desert. They have a north and south direction, and are noted landmarks. Panamint Valley is but a little more than 1000 feet above sea level, and was once occupied by a lake. On the opposite side of the Panamint Range are the desolate reaches of Death Valley which at Bennetts Wells is 276 feet below the level of the sea. In spite of the fact that this region is extremely arid there is plenty of water in Death Valley if one only knows where to look for it. The vast stretch of salt and alkali marsh through the center of the valley is its most dangerous feature. Extensive lakes once occupied the most of the valleys of this desert region.

All the mountains in the region east of the Sierra Nevadas have a north and south direction, and have been uplifted in times as recent as the uplift of the lofty Sierra, if we can judge from their steep escarpments. When we

get as far south as the Mohave Desert, however, we encounter a country possessing a radically different character. Here are very ancient mountains. There have been no important disturbances of the earth's crust, and these old mountains have been almost worn away. The features suggest old age and decay.

For long ages the mountains of the Mohave Desert have been wasting away under the influence of rock disintegration and erosion. Before the uplift of the Sierra Nevadas and the San Gabriel Range disturbed the drainage lines of these ancient times and made the Great Basin the streams undoubtedly flowed away to the sea. They then carried with them the debris of these old mountains, but for a long time past there has been no outlet, and the waste has gone on accumulating in the valleys until in some of them it is probably several thousand feet deep. Where the desert is crossed by the Southern Pacific Railroad we have the best view of these almost vanished mountains. The once young and precipitous mountains have become old, and the processes of decay and erosion have almost ceased. They are probably the oldest topographic features to be found in California, excepting only the region of low relief about Riverside and Perris, in Southern California.

As one goes easterly across the Mohave Desert, on the Santa Fe Railroad, the same old mountains, although not quite so nearly worn down, appear all the way to the Needles. At only two places are there new features, and these consist of small craters and flows of black lava which contrast strongly with the desert sands.

The Mohave river is the only stream of any consequence which enters this vast desert region. It flows northerly from the San Bernardino Mountains and in the direction of Death Valley, but sinks in the sand long before reaching it.

Next to the mountains, the most interesting feature of the desert is the broad, gently sloping plains of rock waste which surround the scattered mountains on all sides and dip away to the sinks. These plains are miles in extent and are made up of gravel or sand which the occasional torrential streams have brought down from the mountains and spread out in sheets. When it does rain here the waters gather quickly on the barren rocky slopes of the mountains, roar through the cañons and then, with their load of rock debris, spread out over miles of country. In such a dry land, where streams are many miles apart, it is strange that the effects of water should be so prominent, but it is nevertheless true. There are places where the railroads have to build many miles of ditches to keep the tracks from being washed out. Occasionally lakes are formed, and in 1909 traffic on the Santa Fe was stopped by such a body of water.

Low, barren mountains, the southeastward prolongation of the San Bernardino Range, separate the Mohave from the Colorado Desert. Reaching the latter we find a very different country from that just described. It is equally barren and destitute of water, at least before the formation of the Salton Sea, but its surface was built up in a very different manner. The Gulf of California once extended as far north as the town of Indio, while the

mouth of the Colorado river was a short distance below Yuma.

The changes in the earth's surface which great rivers effect in the course of long ages, is well illustrated in the work of the Colorado river. The waters of this stream are so loaded with silt during periods of flood that they look like so much seething mud. An estimate of the amount of silt brought down by the Colorado in the year 1890 gave 61,000,000 tons. This is enough to make fifty-three square miles of dry alluvial soil one foot deep, or the same area more than three feet deep with recently settled mud.

Bearing the above facts in mind it is easy to understand how the river in the course of unnumbered thousands of years built its delta across the Gulf of California forming the inclosed area now known as the Salton Basin. The tides of the gulf bore much of the silt farther to the south, so that the total amount of material finally deposited is much greater than that which appears as dry land.

Salton Basin was at first a salt lagoon, being filled with sea water which had been cut off from the gulf by the delta. As the river channels moved here and there over the delta much of the water was at times diverted into the basin, and the lagoon became a fresh water lake. Such was its condition at the time of the last maximum expansion recorded in the ancient beaches and wave-cut cliffs which can be traced all around the borders of the Colorado Desert, for the fresh-water clam shells strew the beaches in countless numbers.

As the river swung back and forth on the delta there were times when no water of any consequence reached the lake, and its bed finally became dry save for the salt marsh in the lowest place. This salt may have been partly derived from deposits left in the ancient salt lagoon, and partly from the accumulation of this material in solution in the river water.

The recent overflow of the river, and the formation of Salton Sea, was due directly to the presence of a canal which at time of high water allowed the river to break through into the basin, but indirectly to the fact that it had been flowing to the south for many years, and that part of its delta had become so lessened in slope that very likely it would have broken into Salton Basin in the course of a few years, even if man had not come in as a disturbing factor.

CLIMATE.—The climate of the Great Basin is one of its most interesting and peculiar features. Every physical condition tends to make a desert of this region. In the first place it lies in the interior of the continent, and is shut off from the sea by mountains. In the second place the mountain ranges extend north and south, and as the storms move easterly with the prevailing westerly air currents of the temperate zone, they abstract a large part of the moisture of the air before it reaches this interior basin. In addition to being very dry the summer temperature of the lower and southern portions of the Great Basin is intense. There is an extraordinary range of temperature between night and day, owing to the clear air and the radiation from the barren surface. The

temperature is further affected by the presence of lofty mountains cutting off the cool sea winds which so greatly temper the summers along the coast.

We have already learned that the storms which pass inland from the Pacific are more numerous in the northern United States, and as these deserts extend pretty well to the south and almost out of the course of these storms, we have an added reason for their dryness. The barrier mountains of the Mt. Whitney region are also more lofty than farther north. It is in the deserts back of these mountains, so to speak, that we have the greatest heat and greatest aridity.

Most remarkable contrasts in climate are found in the Great Basin where lofty mountains break the surface. The tops of those mountains which reach up to 8000 to 10,000 feet have a cool climate with moderate precipitation, while the desert sands at their bases seldom receive rain, and are subject to such high temperature that it would appear as if no living thing could exist.

The climate has given rise to much that is unusual in the topography. The lack of water to form streams has left innumerable basins instead of a series of valleys with a connected drainage system. In some of the basins are lakes strongly impregnated with salts of various kinds. In a normally moist climate there would be found here neither lakes nor salts unless the displacements of the land and the mountain-making movements were so rapid that continuous drainage lines could not be maintained.

The peculiarities of the living things which have adapted themselves to the lack of moisture show how, in

the course of time, climate aids in the development of new species. Among plants, the size of the leaf has decreased in order that there may be less evaporation, and frequently the surface of leaf and stem is covered with a sticky or resinous substance which still further aids in retaining the moisture. Some plants, such as the cactuses, have developed a fleshy body which in certain species holds large quantities of water. Thorns also appear evidently as a means of protection. Among the animals there are also strange adaptations. The most remarkable is the desert tortoise, which has two water pockets, enabling it to exist for a long time without a new supply.

The air conditions are such, particularly in the summer, that when it does rain the precipitation is sudden and heavy, and we call the storm a "cloudburst." Owing to the lack of a protecting cover of vegetation, the water runs off the mountain slopes with great rapidity, spreading out in thin sheets over miles of the desert sands. Some years the rains come at the right time in the spring and the desert soon becomes a veritable flower garden, with many varieties of plants and a wealth of color. The seeds mature, the plants dry up, and in a few short weeks the desert is again a mass of barren gravel and drifting sand. The seeds lie buried, perhaps for years, until another favorable season occurs, when the process is repeated.

In the eastern parts of the Mohave and Colorado deserts the rainfall is rarely in excess of two or three inches, and sometimes two years pass with scarcely any

rain. There is no portion of the desert, however, which does not contain more or less vegetation except the sinks, where, owing to the presence of such quantities of salts of various kinds are apparently absolutely barren.

NATURAL RESOURCES.—The vegetation of the desert varies with the soil, elevation and rainfall. Over the vast reaches of the Mohave Desert the most widely distributed plant is the Mexican creosote bush. Along the dry water courses are many mesquite trees, and in portions of the Colorado Desert these form thorny and almost impenetrable groves. In the moister portions of the desert, particularly toward the north, the sagebrush abounds, and under favorable conditions grows to a height of twelve feet.

In the Mohave Desert there are extensive groves of a tree-like yucca, which sometimes covers miles of the long, gentle gravel slopes. The cactus is more or less generally distributed, but in the western portion of the Colorado Desert it grows in the greatest variety and profusion. The native California palm, so widely grown for ornamental purposes, is found in many of the mountain cañons tributary to the Colorado Desert.

A zonal distribution of plants on the mountain slopes is well illustrated in many places. In the eastern part of the Mohave Desert, for example, we pass from the zone of the Yuccas to that of the desert juniper. Higher still, with more rain and a lower temperature, we reach the piñon pine, and if the mountains be high enough we may reach the yellow pine. As one travels through the desert he can make a rough estimate of the elevation by the kind of vegetation which he encounters.

The fiber of the tree-yucca has qualities which will some day make it useful. Desert plants have large roots in many cases, and these are dug out and used as fuel.

Springs are so rare in portions of the desert that it is unsafe to travel there without a guide. It is interesting to observe upon a map of the desert how the courses of all trails and roads are determined more by the watering places than by any other factors. The difficulty of obtaining water often makes it impossible to work certain mineral deposits which would otherwise be valuable.

It is mainly the presence of minerals in the desert mountains that has called a considerable population into this region. Gold, silver and copper are the most important of the metals obtained. Among the most valuable of the minerals of the Great Basin are salt, soda and borax. Deposits of borax have long been worked in Death Valley and Searles Borax marsh. It also occurs in Saline Valley, east of the Inyo Range. Salt is found in a number of places, both in the form of rock salt and as a loose surface deposit. Salt of the latter kind was obtained from the Salton Sink before it was flooded by the inflow of the Colorado river. The Danby salt marsh, in the eastern Mohave Desert, contains an inexhaustible supply of rock salt. It was quarried at one time and hauled to the railroad by a traction engine. An interesting cabin made of blocks of salt still stands here, for there is not rain enough to dissolve it.

The most noted mining town east of the Sierra Nevada is Bodie, in Mono county. It has many large mines which have produced a great deal of gold. Inyo county

is also noted for its gold mines, and in past years for the production of silver and lead.

Agriculture in the Great Basin is restricted to those areas where water can be obtained for irrigation. The Truckee, Carson and Walker rivers supply large valleys in the northern portion of the district which we have been describing. Owens Valley is well watered, and supports a considerable population. The chief exports are cattle and horses. Apples and many other temperate fruits do well here.

The delta of the Colorado river is composed of a deep and inexhaustible soil, and can for the most part be reached by irrigation ditches. The population of this region, now known as Imperial Valley, is rapidly growing, and many thousands of acres are under cultivation where a few years ago many a desert traveler has perished for lack of water. All the semi-tropical fruits are grown here, and ripen so early that they can be placed on the market ahead of those from any other part of the State.

Not the least among the uses which can be made of the desert is that of a sanitarium. The bracing, life-giving air which moves across its vast stretches is not only a pleasure for the strong to breathe, but is very beneficial to the sick in the case of many diseases.

APPENDIX.

EFFECT OF GEOGRAPHIC CONDITIONS ON THE SETTLEMENT AND DEVELOP- MENT OF CALIFORNIA.

California, as has already been shown, is far from being a geographic unit. Stretching along the Pacific through nearly ten degrees of latitude, and reaching 250 miles into the interior across broad valleys, deserts and lofty mountain ranges, the State presents a remarkable variety of geographic conditions. If we consider the variety of surface features, climates and productions, which range from those of the sub-tropical zone to those of the arctic, we might justly consider California as a whole empire in itself.

It is difficult to say which is the most important geographic factor concerned in the settlement and development of California. It is ordinarily assumed that the location or position of a country is the most important one, but in the region under discussion we shall have to consider much more seriously than is ordinarily necessary the factors of surface features or topography, climate and mineral resources.

We have seen that latitude is of less significance than is usually the case, but that climate as influenced by the ocean, by the direction of the prevailing winds, by the position and direction of the mountain ranges, and by

elevation above the ocean possesses extraordinary importance.

As far as the position of California is concerned in its development we see that it plays a much less important part now than in the period of early exploration and discovery. Lying upon the Pacific, which Spain claimed the right to control, and adjacent to Mexico, what was more natural than that those people should discover and take possession of the region? In its remoteness and geographic isolation from the early English settlements along the eastern shore of the continent there was no reason whatever to suppose that English speaking people would ever control California.

Passing by, for the moment, the Spanish discovery and settlement, we can say that the real development of California began with the discovery of gold. Previous to this event the region was practically unoccupied save for a few small Spanish settlements whose inhabitants had come the comparatively short and easy journey from Mexico, and an occasional American who had either come by some trading vessel or had wandered across the continent.

While the gold seekers came from all parts of the world, by far the larger number were from the Eastern United States. The stories of fortunes to be made in the gravels of the mountain streams started a great migration to a region which not only occupied a remote portion of the continent, but was further isolated by almost impassable geographic barriers. The journey across the continent occupied many months, and was difficult and dangerous. Many went by sailing vessel

around the Horn, but this was fully as long and dangerous as the overland trip. The Isthmus route was shorter, but dangerous, because of the prevailing fevers.

It was the lure of gold, then, which in spite of the most serious physical obstacles, caused the rapid settlement of California. Had gold not existed here California would have been settled slowly by an agricultural population, as in large part was Oregon and Washington. It was gold which kept the almost continuous line of ox teams crossing the vast reaches of the Great Plains. It was gold which led men, women and children to suffer privation and sometimes death on the deserts. It was gold which led them across the lofty Sierras, where snow sometimes blocked their passage, and where their wagons had to be taken to pieces and let down by ropes over cliffs. Without the great incentive offered by gold California would have long remained sparsely settled. The larger number of Eastern emigrants would have awaited the coming of the transcontinental railroad—that modern leveler of physical barriers.

We can say, then, that the situation and geographic environment of California would have tended, under ordinary conditions, to make its growth in population slow. To be sure, many people would have come overland to settle in the fertile valleys, as they did in Oregon. Many would have made homes on the prairies and great plains of the Middle West, and transportation by boat would have played a relatively more important part. People would not have hurled themselves blindly against such dangerous barriers as under the then existing conditions surrounding California.

The position of California made it natural that Spain should explore and send the first settlers to its shores. The advantage which she had was, however, not followed up. The remoteness of the province, and the ease with which the people supported themselves on the rich soil, and in an agreeable climate, tended toward stagnation instead of advance. If the people had been progressive the geographic barriers which separated California from the East would have aided Mexico greatly in retaining it.

It is easy to understand why the early exploration of California was not carried on by land expeditions from Mexico. One party got as far north as the Grand Cañon, but could not cross it. Another went up the Colorado river from the Gulf of California, but owing to the bare and forbidding aspect of the country the men did not dare to go far from their boats.

We are accustomed to think of the sea as the great highway, and the shores of a new country as most easily explored by boat. We would naturally think it a simple matter for the explorers and settlers from Mexico to make their way north along the Pacific Coast, but as a matter of fact this was not the case. The narratives of all the expeditions by water speak of the scarcity of good harbors, and the constant succession of head winds. It often took as long for a vessel to beat up the coast as for an expedition to traverse the distance by land. It is interesting to note, then, what little advantage California had in the early days from her position upon the Pacific.

Nearly all new countries were traversed first by means of their rivers and lakes. In California, however, and in fact throughout all the vast region extending eastward

to the Missouri river, the emigrants and explorers met with scarcely no assistance from the waterways. The Platte and Arkansas rivers were generally too shallow for the use of boats, while the Colorado was found buried in an inaccessible cañon, and the Snake broken by cañons and rapids. The Columbia was used for a comparatively short distance from The Dalles to the sea. In California the only inland water made use of by the emigrants was about 100 miles of the lower Sacramento, between the town of the same name and San Francisco.

The missions of San Diego, Monterey, Santa Barbara, Santa Cruz and San Francisco were located with reference to harbors, while the sites of the others which were strung along the main highway connecting these, and which reached as far north as Sonoma, were chosen with especial reference to the presence of water for irrigating their gardens. The Mission Fathers were not long in discovering that California had a climate similar in many respects to that of Mexico, and it was their first care to select well watered and fertile valleys for the founding of their establishments.

Owing to the fact that the country appeared drier and more forbidding toward the interior, the settlements which grew up along the line of Missions showed little tendency to spread far from the coast. The priests discouraged attempts at mining, and there was little other inducement to explore the vast and almost unknown interior. The isolation of California tended to make the people self-supporting, and to the development of a quiet and peaceful life. There was no market for products other than hides and tallow, which the New England

trading vessels occasionally called for, and so cattle raising became the only important industry.

We find, then, that up to the period of gold discovery geographic conditions determined in the fullest degree the position of the settlements and the occupation of the people. If it had not been for this discovery the development of California as an agricultural and commercial State would have proceeded along much the same line as the Spanish settlement. The seaports and valleys where water was abundant would have received the bulk of the emigrants, and from these they would gradually have spread, as they learned to make use of irrigation, into the drier valleys and mountains. As it was, however, the search for gold carried the bulk of the people away from the distinctly agricultural districts and into the gulches and cañons of the Sierra Nevada and Klamath mountains.

The situations chosen for the numerous towns which sprang up through the foothill belt as a result of the mining excitement are in many cases peculiar and interesting. The location of each was determined by convenience to some particularly rich "bar" or stream. Some of them were in narrow gulches or on steeply sloping mountain sides, and they were rarely placed with regard to agricultural possibilities or thought of future lines of travel and communication.

The only available port in which supplies could be received by ship, and all had to come that way, was San Francisco, and that little town soon became a bustling city. From San Francisco goods and passengers could easily reach Stockton, Sacramento, Marysville and Red

Bluff, from which points they were distributed to the various mining camps. It is very interesting to compare San Francisco and Monterey as regards their growth during the gold excitement. Monterey was one of the oldest places in the State, as well as metropolis and early capital, while San Francisco was merely a little hamlet. The geographic position and environment of these places became all-important. Monterey, although situated in a fairly well protected bay, had no direct connection with the interior, and was, moreover, farther from the mines. It lay upon no line of communication with them, and scarcely felt the exciting events of the gold period, and up as late as 1890 it remained one of the most typical of the old Spanish towns of California.

The wonderful growth of San Francisco was foreshadowed by its position upon the great bay. There is no other place upon the Pacific Coast of the United States so clearly adapted by nature to be the seat of a great commercial city. The situation of San Francisco Bay is central, and with its arms and tributary valleys reaching out into the heart of the central and northern portions of the State, it controls an area which will some day be populated by many millions.

The situation of Sacramento gave it an advantage over the other valley towns which came into existence as supply points for the mines. Larger boats could ascend the Sacramento river to this point than could reach the other places. Sutter Fort was situated on the American river near the town, and was a well known rendezvous for all the early emigrants, so that all the main overland trails converged here.

At the breaking out of the gold excitement Captain Sutter was engaged in growing grain in the Sacramento Valley, but home-raised supplies of all kinds, with the exception of meat, were soon entirely inadequate to meet the demand, and living became very high. No one wanted to do such prosaic work as farming when gold was to be had for the mere digging in the river gravels. In a comparatively short time matters began to mend, for the richest placers were soon exhausted, and those unsuccessful at mining, as well as the late comers, turned to agriculture.

After a time the ancient river channels were opened up by means of hydraulic mining, and quartz veins began to be discovered and worked, but these operations employed comparatively few men, and the great bulk of the population which had so quickly gathered began to slowly drift away. Scores of once bustling towns grew quiet, and after a few years many of them were recognized only by deserted and tumble-down buildings. With the increase in the agricultural population and the development of manufacturing and trade California society began to take on a normal character.

We have already traced the agricultural growth of the State from the period of stock raising through the period of the great ranches which were given over largely to grain, to the modern period characterized by diversified farming and growing of fruits upon small and carefully cultured tracts. Each of the above periods existed as the result of definite geographic conditions, whose modification led to the transition to the next stage.

Owing to the isolation of California under Mexican rule, the chief products which could be profitably shipped were hides and tallow, and there would have been no demand for these if it had not been for the energy and pluck of the New England trading vessels. With the growth of the population there came a demand for meat and grain. The former could be driven any reasonable distance to market, but the profitable growing of grain was limited to those areas near water transportation, until the railroads were extended through the main valleys.

The development of California has been greatly retarded through the lack of internal waterways. The various arms of San Francisco Bay within comparatively short reach of the Sacramento river and its tributaries being the only ones available.

From a geographic standpoint, no finer conditions could exist for an important waterway than those furnished by the Great Valley and the drainage lines in it. By proper dredging, the Sacramento river could be used for freighting crops and merchandise to a point nearly or quite as far north as Redding. In the San Joaquin Valley only a slight divide of about twenty-five feet separates the waters of the San Joaquin from the basins of Lake Tulare and Buena Vista Lake. A canal could be constructed from the latter lake, at the southern end of the San Joaquin Valley northwesterly to the San Joaquin river and tidewater, with no serious engineering difficulties in the way, thus affording a cheap outlet to one of the greatest and richest garden spots of the world.

Irrigation was first looked upon by the settlers from the East as a laborious and tedious method of growing

crops, and it was some time before they began to understand its application, and the great advantage which it offered in enabling them to moisten the ground just when moisture was needed, rather than to depend upon chance showers.

Irrigation is of great importance to California, not only because there are large areas where the rainfall is insufficient, but because much of what does fall comes at the wrong season of the year. Winter is the wet season in California, and at that time the weather is so cool that plants grow but little, even in the warmer valleys. As spring comes on the precipitation grows less, and finally ceases entirely in the summer months, just when growing things need it the most.

Another thing which makes irrigation easy to carry out on a large scale is the fact that the extensive lowland valleys lying about the bases of the mountains in which the streams head, have a gentle, even slope just suited to canals and ditches. At the mouth of every cañon there has been built up a broad flat debris cone, and it is the union of these cones in one broad plain which gives rise to the valley slopes.

The importance of lofty mountains in a region deficient in moisture is clearly illustrated in California. They not only increase the precipitation several times what it otherwise would be, but much of it is left in the form of snow, which melts slowly and aids greatly in keeping up the summer flow of the streams. A supply of water for irrigation is thus made possible where, if the mountains were absent, the region must remain an unproductive desert.

The possibilities of irrigation for the growth of fruit and vegetables could not be fully realized until a market could be obtained outside of the State. The building of the transcontinental railroads was the final link in the chain of causes and effects, and was really the opening up of our modern California development. Dried fruits, grain and other non-perishable products could be shipped around the Horn by boat, but until the railroads came there was no market for fresh fruit outside the State and the immediately adjoining coastal regions. With the rapid overland trains we now deliver fresh fruit and vegetables by the thousands of carloads all over the United States.

The growth of manufacturing industries in California has been seriously affected by geographic conditions. The cost of living continued high for many years following the gold excitement because of the comparatively small attention given to agriculture, and so it was difficult to compete with eastern products. Besides this, almost all the coal used had to be imported by boat from distant countries. Although iron deposits are known to exist in California, little, if any ore has been mined and smelted. The recent discovery of immense petroleum fields in the Coast Ranges, whose deposits seem inexhaustible, is a very important thing for manufacturing, since the larger part of the oil is better adapted for fuel purposes than any other.

If we except the redwoods along the coast; the forests of California are found mostly in the mountains, and were difficult to reach by the means at the command of the early settlers. During the period of the gold excite-

ment materials for many houses were brought around the Horn.

Owing to geographic conditions being very different from those surrounding the forests in the Eastern States, lumbering in California has been carried on in a different manner. The rivers were not available for "log drives," since they were generally found to flow swiftly over rocky beds through deep cañons. In order to get the lumber to market, then, mills were erected in the forests in the mountains, and flumes constructed leading from the mills at a gentle grade down to the valleys where they connected with the railroads. As the logs were sawed the lumber was thrown into the flumes, which were filled with water, and borne by its rapid current around the mountains and along the sides of cañons a distance sometimes of thirty to fifty miles.

We have seen that physical conditions such as climate, water supply, nearness to the ocean, or to that great highway known as the Camino Real, were the determining factors in the location of the early Spanish settlements. We have seen also that with the discovery of gold physical conditions were practically ignored. Men braved every danger and surmounted every physical obstruction in their rush for the mines. Outside of the supply towns and the port of San Francisco the population was mainly concentrated in the gold belt. With the exhaustion of the placers the population began to spread according to the demands of agriculture, that most fundamental of all occupations.

The marked differences in climate of various parts of the State influenced the distribution of the early agri-

cultural population even more than physical features and accessibility to market. People settled first where the rainfall was sufficient to grow the common crops with little or no irrigation. Large areas in Southern California and in the San Joaquin Valley were passed by, although the soil appeared to be of the best. Nearness to water, either springs or streams, determined the locations of the first homes under irrigation. Then came the leading of water by ditches and canals many miles onto land which was worthless without water, and with this the apparently desert portions of the State began to settle up.

Another factor which affected the distribution of the early agricultural population, and in some degree affects it today, was the existence of Spanish grants. Nearly all the valleys of Southern California, as well as parts of the adjacent mountain slopes which were of value for grazing purposes, and all the valley lands of the Coast Ranges as far north as the San Francisco Bay region, had at some time been granted by the Mexican government to the early Spanish settlers, and these titles were confirmed with the transfer of the region to the United States. Stock raising has continued down to the present to be the only industry upon some of these grants, while others have been devoted to grain. The most of these grants have now been cut up into small tracts for intensive farming.

The effect of climate on the distribution of the various agricultural pursuits forms an interesting study. The State is divided into belts and zones, some of which are determined by elevation, others by their position with relation to the ocean. Oranges, lemons, figs, olives,

raisin grapes, etc., are grown to best advantage in the warm interior valleys. Many fruits belonging naturally in a more temperate climate do well in the same valleys. Among these are peaches, pears, apricots, plums and prunes. The latter really do better, however, in the cooler valleys near the coast, as well as in the mountain valleys where the elevation is too great for citrus fruits. Cherries do not produce in the hot valleys, nor are the apples grown there good. The best apples are grown in the mountains at an elevation of 3000 to 4000 feet, but all through the Coast Ranges there are many favored spots at a much less altitude where large quantities are raised.

Few fruits do well upon the open coast where they are exposed to the winds off the ocean. This belt is, however, especially adapted to dairying, since the cool air, moisture, and more abundant grass through a longer portion of the year are all favorable factors. Since the development of irrigation and the growing of large quantities of alfalfa dairying has been carried on much more extensively in the interior.

In the lowland valleys of the Coast Ranges, too cool or frosty for citrus fruits, the walnut and almond are grown extensively. Beans do best in the sandy soils of the damp coastal region. The variations of soil and climate in California are so great that space forbids the presentation of more detail along this line. We should make note, however, of the remarkable variety of fruits and vegetables which, though here grown to perfection side by side, are ordinarily found in different climatic zones.

Each of the seven provinces under which the State has been discussed in the previous pages has certain fairly well defined physical and biological characteristics which should enable one to recognize it when these are described. The importance of having a clear mental image of the relief of California, in the light of what has already been said, cannot be over estimated.

It should be noted further, in connection with a study of the influence of relief, that the rivalry which has at times existed between Northern and Southern California, and threatened to start a movement for State division, has a real basis in geographic conditions. The Mohave Desert, with its plateau-like surface and inclosing mountain ranges, which separate it alike from Central and Southern California, forms a great wedge pointing westward which almost cuts the State in two parts. In earlier times this barrier would have given rise, without doubt, to two separate peoples having their communication mainly by water. With modern means of communication afforded by the railroads, deserts and mountains are practically obliterated. As it is now merchants in Los Angeles actually ship goods across this once important barrier into the San Joaquin Valley in competition with the merchants of San Francisco.

In looking over the physical conditions under which California life is developing, we see that physical barriers can be overcome. We see that water can be conducted from where it is abundant to where it is needed in order to utilize the land, as illustrated in the fullest degree in the case of the Los Angeles aqueduct. There

is one factor, however, that cannot be changed by man, and that is climate.

We cannot make the climate in a given place either warmer or colder, nor can we change the amount and distribution of the rainfall. We can, however, seriously affect the benefits of the rainfall by careless treatment of the forested slopes about the heads of the streams. If we cut down the forests and remove the humus cover from the soil the waters will run away in floods, bearing the best of the soil with it, while the floods will be followed by almost dry stream beds in the long, hot summers.

The future development of California is intimately dependent upon the careful and rational conservation of its forests and streams. The geographic environment given us by Nature can be modified in some ways, but in others its exactions are merciless.

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Supplementary to the main model of the State of California, in the northeast corner of the map a relief model of San Francisco and vicinity is included. This is modeled on an enlarged scale, namely, four miles to the inch, with a vertical scale of three to one. It shows the topography of San Francisco, the harbor and the surrounding country to much better advantage than is possible on the regular map of smaller scale. Los Angeles and vicinity is also treated in the same way on a scale of ten miles to the inch and vertical scale of two to one.

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